TSCA Title IV, Sections 402(a) and 404: Target Housing and Child-Occupied Facilities Final Rule Regulatory Impact Analysis

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EXECUTIVE SUMMARY

Introduction

In response to continuing concerns about lead poisoning among American children, Congress passed the Housing and Community Development Act of 1992, which included Title X: the Residential Lead-Based Paint Hazard Reduction Act of 1992. Title X amended several existing housing, worker safety and environmental regulations, and added Title IV: Lead Exposure Reduction to the Toxic Substances Control Act (TSCA).

Provisions under §402(a) of Title IV require that all individuals engaged in lead-based paint abatement activities be properly trained, that training programs be accredited, and that contracting firms be certified for conducting lead-based paint activities. Title IV also requires the U.S. Environmental Protection Agency (EPA) to establish standards for performing lead-based paint activities that are reliable, effective, and safe. These lead-based paint activities are voluntary under §402(a). Section 404 authorizes states to administer and enforce their own lead-based paint program, which shall be "as protective" as EPA's Federal program under §402(a). Section 404 also requires EPA to develop a model state program that may be adopted by states seeking to administer and enforce a program under Title IV. This report analyzes the costs, benefits, and impacts of regulations promulgated through §§402(a)/404 of TSCA, Title IV.

The benefits of §§402(a)/404 are the value to building owners of increased confidence in and reduced uncertainty about the quality of lead-based activities that they may purchase. This increased confidence may lead to incremental risk reduction brought about by performing inspections, risk assessments, and abatement activities using trained labor that complies with the performance standards. The categories of potential risk reductions include:

- Reduced exposure to lead-based paint hazards by residents of target houses and child-occupied facilities as a result of more effective lead-based paint and soil abatements.

- Reduced exposure to lead-based paint hazards by other individuals who live, work, or travel near lead-based paint activities being performed by trained workers adhering to the work performance standards.

- Additional reductions of occupational exposure (beyond that provided by OSHA worker protection regulations) to lead hazards by lead-based paint abatement workers as a result of training in, and adherence to, work performance standards for inspection, assessment, and abatement procedures.

- Reduced ecological damage from lead exposure due to adherence to work performance standards, during lead-based paint abatements.

The costs of the regulation are based on the number of lead-based paint events that will occur following promulgation of the rule and the future demand for trained and certified personnel. The costs fall into three categories:

- **Work Practice Standards:** Costs resulting from the imposition of work practice standards for performing lead-based paint activities;

- **Training, Accreditation, and Certification Requirements:** Costs resulting from the training and certification requirements (including the accreditation of training providers) for lead-based paint inspection, risk assessment, and abatement personnel; and

- **Program Administration:** Costs of establishing and operating State, Indian Tribe, or Federal programs to administer, monitor, and enforce the standards, regulations, and other requirements established under §§402/404.

Estimate of Costs

Exhibit ES-1 displays the estimated first-year costs, discounted costs, and respective percentage of incremental costs by category of §§402(a) and 404. The first-year costs are estimated to be $31 million. Discounted at a rate of 3 percent over 50 years, the costs total $1,114 million. Costs of compliance with work practice standards were estimated at $637 million and accounted for 57 percent of the discounted costs. The work practice standard costs are the main source of costs due primarily to the costs of requirements imposed on risk assessments and abatements in target housing.

Exhibit ES.1: Estimate of the Incremental Costs of Sections 402(a) and 404 of Title IV

Cost Category	First Year Cost (millions)	Second Year Cost (millions)	Discounted Cost* (millions)	Percentage of Total Cost
Training	$16	$5	$228	20%
Standards	$0	$20	$637	57%
State Program Administration	$16	$10	$249	22%
Total	**$31**	**$35**	**$1,114**	**100%**

*Costs discounted at 3 percent for 50 years

Estimate of Benefits

The objective of the benefit analysis is to identify the incremental benefits associated with §§402(a) and 404. These benefits are the value to consumers of being able to purchase lead-abatement services of more reliable quality. As a result of the reduced uncertainty about the quality of such services, more inspections, lead hazard screens, risk assessments and abatements will be performed. In addition, the average quality of the services that are performed will rise as the low-quality lead-based paint activities are curtailed or eliminated by the accreditation, training, certification and work-practice standard requirements. The quantification and valuation of these benefits--the ability to purchase a service of more reliable quality and the improvement in quality--would require information about the distribution, by quality, of lead-based paint activities that building owners may purchase, if this rule were promulgated and in its absence. Due to data limitations, however, it was not possible to estimate the benefits of the rule. Instead, EPA estimated the total benefits of abatement.

The number of quantifiable and monetizable benefit categories in the analysis of abatement benefits is limited because dose-response functions necessary to assess the potential impacts of lead-based paint hazard reductions on human health and the environment are not available, and knowledge of national blood-lead levels pre- and post-implementation of §§402(a) and 404 is also unavailable.

Exhibit ES-2 presents the total first-year and total discounted measurable benefit estimates by relevant benefit category. First-year total measurable benefits are estimated at $625 million. Total measurable benefits, discounted at 3 percent over a 50-year period, are estimated at $16.1 billion.

The largest category of measurable benefits accrues from reductions of negative impacts on children's intelligence, with an estimated present value of total measured benefits of $16.1 billion ($13.1 billion in target housing and $3 billion in child-occupied facilities).
The inclusion of neonatal mortality, infant/child neurological benefits, adult resident and worker benefits, and ecological benefits would substantially increase the estimated benefits from abatement. These benefit categories could not be measured, however, due to unavailable data. The sensitivity analyses in Chapter 7 indicate that the additional benefits of abatement from three of these categories, neonatal mortality, workers and adult residents of target housing, could be as much as $38 billion when discounted over the 50 years, at 3 percent.

ES-2: Summary of §§402(a)/404 Total Measured Benefits*		
Benefit Category	**Present Value of Benefits from Abatements Performed in the Second Year Rules in Effect** (Millions)**	**Present Value of Benefits from 49 Years of Abatements† (Millions)**
Children in Target Housing	$499	$13,100
Children in Child-Occupied Facilities	$126	$3,000
Total Benefits of Abatements Affected by §§402/404	$625	$16,100

*Total measured benefits, including incremental benefits from §§402/404. Benefits are from value of IQ loss avoided and cost of compensatory education. **These are the present value of the stream of benefits accruing over 50 years because of abatements in a single year. †Benefits discounted at 3% for abatements occurring during 1998 through 2047.

Sensitivity Analysis

Six sets of sensitivity analyses were conducted to examine the effects on key categories of the benefits of abatements and cost categories. Two sets affected the costs: alternative work practice standard costs, resulting from alternative estimates of likely soil abatement practices, and alternative demand for training and thus training costs, resulting from alternative assumptions of likely workload. In addition, varying assumptions of changes in blood-lead levels attributable to the rule provide estimated potential benefits for neonatal mortality and adult residents of abated units, and lead-based paint workers.. Finally, a different discount rate of 7 percent was tested for its effect on both the estimated costs of the rule and the benefits abatement.

As shown in Exhibits ES-3 and ES-4, the greatest impacts result from the use of an alternate discount rate and inclusion of adult resident benefits. Simply discounting the stream of costs by 7 percent decreased the present value of the 50-year incremental cost estimate by 52 percent. Correspondingly, the use of the 7 percent discount rate decreased the present value of the 50-year stream of abatement benefits by 90 percent. Incorporation of adult resident benefits increased total benefits by $1.8 billion per 0.1 μg/dL change in blood lead for the same analysis period, without impacting the costs.

ES-3 Sensitivity of Cost Estimates to Variations in of the Value of Key Variables			
	Total Discounted Costs ($ millions)		
Variation in Key Variable	Primary Analysis	Sensitivity Analysis	% Change from Primary Analysis
Reduce the Demand for Inspectors & Risk Assessors	$1,114	$1,050	-6%
Increase Soil Abatement Depth (to 6")	$1,114	$1,406	+26%
Use 7% Discount Rate	$1,114	$530	-52%

ES-4: Sensitivity of Benefit Estimates to Variations in the Value of Key Variables			
	Total Discounted Benefits ($ billions)		
Variation in Key Variable	Primary Analysis	Sensitivity Analysis	% Change from Primary Analysis
Include Benefits to Adult Residents, Assuming 2.13 μg/dL Change in Blood Lead	$16.1	$52.1	+224%
Include Benefits to Adult Residents, Assuming 0.1 μg/dL Change in Blood Lead	$16.1	$17.9	+11%
Include Benefits to Workers (Capturing 20% of Workers not covered by OSHA PEL)	$16.1	$16.3	+1%
Include Neonatal Mortality, Assuming 2.13 μg/dL Change in Maternal Blood Lead	$16.1	$17.6	+9%
Use 7% Discount Rate	$16.1	$1.55	-90%

Impacts of the Proposed Rule

In addition to the benefit-cost analysis, a number of social impacts of the rule were evaluated. First, impacts on industry, including estimates of potential impacts on small businesses were investigated, as well as reporting and recordkeeping costs and burdens.

Second, an equity analysis was developed to address the distributional consequences of the regulation on environmental equity.

The 1980 Regulatory Flexibility Act (RFA) requires regulators to analyze the impacts of regulations on small entities, in particular, small businesses. To examine the impacts of the regulation, §402(a) training and certification compliance costs per establishment were compared to the establishment's current operating costs. The ratio of compliance costs to sales generally falls within a relatively narrow range, from .6% to 3.2% and from .6% to 1% for small and large abatement firms, respectively.

Under the Paperwork Reduction Act (PRA), EPA is required to estimate reporting and recordkeeping costs and burdens associated with the requirements specified in the rule. During the initial year of the rule, the **reporting/recordkeeping** burden is projected to be about 401,400 hours (State burden 48,400 hours and private sector burden 325,000 hours), at a cost of approximately $8.4 million. Each year thereafter will have a burden of approximately 307,000 hours (State burden 2,750 hours and private sector 304,000 hours) and $6.4 million. Triennially there will be an additional burden of 1,080 hours and $24,350 for re-accreditation and state auditing related requirements.

Existing lead-based paint hazards is a risk to all segments of the population living in pre-1978 housing. However, literature indicates that poor, inter-city, minorities are at relatively greater risk than others. An assessment of the distribution effects of this rule would entail information about the distribution of the costs and benefits of the rule. EPA lacks information about how the costs and benefits of the rule are distributed by income and race. EPA notes, however, that while the baseline risks from lead-based paint fall disproportionately on poorer sub-populations, it may be more likely that abatements will take place in housing units occupied by mid- to upper-level income households. Abatements will be voluntary, and wealthier households are more likely to have the financial resources to abate an existing problem in their home, or avoid lead-based paint hazards by not moving into a housing unit with lead-based paint. Even though a national strategy of eliminating lead-based paint hazards targets a problem affecting a greater share of poor households and minorities, the impact of income on the ability to undertake voluntary abatements may result in a more inequitable distribution of the risks in the future. Several Federal agencies have established grant programs that will provide financial support to reduce the prevalence of lead poisoning among disadvantaged children. The EPA also has several information initiatives designed to educate the public, with particular emphasis on this socio-economic group, of the dangers of lead hazards.

Likewise, there is insufficient data to determine whether the requirements of this rule will place a disproportionate burden on minority-owned firms and/or minorities working in lead-based paint activities. There are, however, several federally and locally funded programs to assist minorities in getting training and certification under this rule.

Under the Unfunded Mandate Reform Act (UMRA), EPA is required to prepare a written statement of effects of Federal regulatory actions on state, local, and tribal governments, and the private sector. The Act applies to "any Federal mandate that may result in the expenditure by state, local, and tribal governments, in aggregate or by the private sector, of $100,000,000 or more (adjusted annually for inflation) in any one year.” Since the cost estimates of this rule will not exceed $100,000,000 in any one year, the requirements of UMRA were not addressed.

Conclusion

The purpose of this Regulatory Impact Analysis (RIA) was to analyze the benefits, costs, and economic impacts of the final rule implementing §§402(a)/404. The costs of this rule are estimated to be $1,114 million, if discounted at a rate of 3 percent. As demonstrated above, however, the potential benefits to society associated with lead-based paint hazard reduction is great. These benefits include $16.1 billion from the avoidance of negative impacts on children’s intelligence, and possible additional benefits from neonatal mortality, workers and adult residents of target housing. The total benefits could be as much as $54 billion over 50 years.

Another way to evaluate the rule is to look at it from the perspective of the individual decision maker. The costs facing the typical owner, composed of the total costs of an inspection, risk assessment and abatement (including the incremental costs resulting from the work practice standards, and the unit's pro-rated share of training costs and state administration costs) are $7,276, of which only $248 are incremental costs due to this rule. Compared to the per residential abatement benefits to children of $9,181, total benefits exceed total costs. In addition, the total net benefits are larger than this comparison indicates because data limitations preclude the valuing of several benefit categories. If the property owner has a lead-hazard identification performed (e.g., inspection/risk assessment) and decides that an abatement is not warranted, then the benefit to the owner equals the cost avoided because the abatement is not performed. In the case of child occupied facilities, the information from the lead-hazard identification provides the basis for avoiding potential liability from possible exposure of children to lead hazards.

Based on all this information, EPA believes that §§402/404 provides a vehicle that will aid in the realization of the benefits resulting from the reduction in risk from lead-paint hazards, and that in light of the potential magnitude of these benefits, this rule is reasonable.

1. INTRODUCTION

In response to continuing concerns about lead poisoning among American children, Congress passed "Title X: The Residential Lead-Based Paint Hazard Reduction Act of 1992." in October of that year. Among the several goals stated in this legislation are:

- to encourage effective action... by establishing a workable framework for lead-based paint hazard evaluation and reduction, and

- to mobilize national resources expeditiously... to develop the most promising, cost-effective methods for evaluating and reducing lead-based paint hazards.

Among other actions, Title X amends the Toxic Substances Control Act (TSCA) by adding a new title: Title IV — Lead Exposure Reduction.

EPA established a §§402/404 Lead-Based Paint Activities Workgroup to develop regulations under §§402(a) and 404 of Title IV. The Workgroup held meetings with members of the regulated community and other interested/affected parties as they developed the Proposed Rule, which was published in September, 1994. The Agency solicited and received numerous public comments on the Proposed Rule. These have been carefully considered in developing the Final Rule. As a result of this process, the Final Rule is much more efficient while accomplishing the same objectives.

The study presented in this report analyzes the cost and benefits of two sections of this Act. Section 402 mandates that all individuals engaged in lead-based paint activities in target housing and child-occupied facilities be properly trained, that training programs be accredited, and that contracting firms be certified. It also requires EPA to establish standards for performing lead-based paint activities that are reliable, effective and safe. Section 404 authorizes states to administer and enforce the standards and regulations established under Sections 402 and 406. Section 406 requires the disclosure of possible lead-based paint hazards in connection with renovations of residential properties and upon transfer of such properties, and is being implemented under separate regulations. Section 404 also requires EPA to develop a model State Program that may be adopted by States seeking to administer and enforce a State program under this Title.

Since the initital release of the proposed rule, several changes have been made in developing the Final Rule. Among the changes made was limiting the scope of the regulations in terms of structure types covered. The Proposed Rule, and accompanying Regulatory Impact Analysis (RIA), addressed residential, public, and commercial buildings and steel structures. Residential buildings are defined as target housing and include any residential housing unit built prior to 1978. In response to the comments, EPA redefined the "public building" category by separating it into two categories: child-occupied facilities and other public buildings. In addition, EPA reduced the scope of the regulations to cover only target housing and child-occupied facilities. These changes have substantially reduced the cost of the regulation, as reflected in this RIA.

The regulations resulting from Title IV will take effect in a context of other federal and state regulations governing the use and abatement of lead-based paint. As such, the incremental costs and incremental benefits resulting from the changes caused by the §§402/404 regulations should be evaluated within the RIA. Data limitations, however, preclude the estimation of incremental benefits. Total benefits are estimated and presented as a basis for the impact analysis.

This report contains ten chapters. Chapter 2 describes the current market for training and abatement services and the current regulations affecting these activities. Chapter 3 defines the problems that the regulations will address. Chapter 4 provides an overview of the analysis, which becomes the basis for estimating costs and benefits. This is followed by an analysis of the regulation's costs (Chapter 5) and benefits (Chapter 6). A sensitivity analysis is presented in Chapter 7, followed by a comparison of the benefits and costs of the regulation (Chapter 8). Impacts on specific groups or activities, such as on small entities and international trade, are presented in Chapter 9. Chapter 10 compares the costs of this Final Rule with the estimated costs of the rule as proposed in September 1994.

2. MARKET PROFILE

This chapter summarizes the current market for lead-based paint activities for target housing and child-occupied facilities. It also summarizes existing state and federal regulations addressing lead-based paint. The purpose of the chapter is to describe the baseline conditions affected by the final rule.

2.1 Market for Training Provision

After the Consumer Products Safety Commission substantially restricted the lead content of house paint in 1973 and 1978, several federal and state laws were passed addressing lead paint activities in the United States. Prior to TSCA §§402 (a) and 404, however, the only federal regulations to specifically address training for lead abatement professionals were the Department of Housing and Development (HUD) rules for Public and Indian Housing. As of June 1995, twenty-nine states had laws concerning lead paint, but only thirteen states addressed training and/or licensing in their laws.[1] The Massachusetts laws requiring the training of lead professionals have been in effect since early 1990, while the training laws in other states have been in effect for much shorter periods of time. Existing states' lead laws are summarized below in Section 2.4.

Little data is readily available on which to base a comprehensive characterization of the national market for lead training. There is no national mechanism to track lead training, and only in Massachusetts has a law been in effect long enough to provide extensive data on a state market. Limited information is available on private training providers located outside of Massachusetts. Over the past few years, however, EPA awarded grants to Regional Lead Training Center consortia to encourage lead training. These consortia are currently providing training nationally and are a relevant data source for the analysis.

2.1.1 Data Sources

The market profile presented in this chapter is based primarily on three sources of information:

- Brochures and survey responses received from private training providers
- Discussions with staff of the Regional Lead Training Centers
- Information provided by Massachusetts State Agencies

Private Training Providers EPA contacted several private training providers to request brochures and other information regarding their training courses. Upon receipt of this information, nine private providers were contacted to ask if they would be willing to fill

[1]Several of these laws were in direct response to Title X requirements.

out a survey about their training program. Four providers, located in four states, completed and returned the survey.

Regional Lead Training Centers (RLTCs) EPA has a cooperative agreement with six university-based lead training centers making up the five RLTCs. Each RLTC represents two EPA regions: Northeast (Regions 1&2), Great Lakes (Regions 3&5), South (Regions 4&6), Mid-states (Regions 7&8), and Western (Regions 9&10). Each of these RLTCs has between three and thirteen institutions that are approved to give the lead training courses. The consortia members include representatives from higher education, labor, state lead programs, and the nonprofit sector.

The goal of the RLTC program is to address the problems of lead poisoning by establishing a professional community that is highly qualified in lead-based paint activities. To meet this goal, the RLTCs develop EPA model courses and provide training to lead abatement professionals.

The RLTCs have developed a supervisor/contractor, worker, and inspector course which are offered by all of the RLTC and consortia members. The risk assessor and project designers courses are in development, although as of 1995, several centers were offering the risk assessor and the project designer course prior to EPA curricula approval.

Massachusetts Training Provisions In 1989, Massachusetts enacted a law governing lead-based paint activities. Part of this rule required training for lead inspectors, contractors, supervisors, and workers. In addition, Massachusetts requires that all training providers be accredited by the state. Massachusetts has required lead training for a longer period of time than any other state and is the most mature lead training market in the U.S. It is unlikely that the development of the Massachusetts market perfectly predicts the development of a national market for two reasons. First, Massachusetts state laws have slightly different requirements than Title IV.[2] Second, the proportion of structures with lead paint in Massachusetts is higher than in some other regions of the country. The Massachusetts experience does, however, provide insight into the factors which effect the national lead training market.

In Massachusetts some training providers concentrate either in inspector or in worker/contractor/supervisor training while other providers offer the full range of courses.[3] Exhibit 2.1 summarizes the number of Massachusetts certified institutions offering courses for each discipline in 1995. Of the nineteen certified providers, only eight offer the full range of courses.

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[2]See Appendix 4.B for a description of the Massachusetts laws.

[3] As described later in this chapter, Massachusetts has separate requirements for contractors and for supervisors.

Training specialization can result from two factors. First, the types of equipment required and the pool from which trainees are drawn differ for inspectors in comparison to worker/contractors and supervisors. Second, training in Massachusetts is governed by three separate agencies. The Massachusetts Department of Labor & Industries oversees the training of worker/contractors and supervisors, the Massachusetts Department of Public Health oversees the inspector training, and the Department of Environmental Protection oversees disposal training.

Exhibit 2.1: Massachusetts Certified Training Providers as of June, 1995

Courses Offered	Number of Training Providers Certified in Massachusetts
Total, of which:	19
Inspector Only`	4
Workers and Supervisors/Contractors	7
Inspector, Supervisors/Contractors, and Workers	8
Total Providing Supervisors/Contractors and Workers Training	15
Total Providing Lead Inspector Training	12

2.1.2 Training Provider Profile

Based on information from training providers' brochures and discussions with RLTC staff, the training market is divided between private and university-based programs. Training programs tend to be staffed with three to five people for both private and university-based programs. Most of the private providers also offer training in other occupational areas, such as asbestos inspection and abatement.

The Massachusetts training market is dominated by private companies, each operating one training facility. The Northeast RLTC does, however, offer several training classes in Massachusetts during the year. A few private providers have satellite offices which offer accredited training in other states. One provider has a mobile unit and "is willing to travel to wherever there is a demand." Special arrangements can be made with some providers for in-house training.

In general, the RLTC training courses are offered at the facilities of the university or other consortium member; they do not offer courses at work sites. The individuals staffing the RLTC programs are frequently "borrowed" from other program areas within the university.

The growing field of environmental consulting firms include lead inspection and abatement training as one of a number of services they offer to the construction industries. Private industry consortiums (PICs), which are common in California, are working with the Western RLTC to eventually offer lead abatement training. The formation of the RLTC network sponsored by EPA has encouraged community colleges and universities to offer lead inspection and abatement courses. In addition, trade groups, such as the Steel Structures Painting Council, provide training in lead work to their members. This group of providers remain specialized or localized; however, it is conceivable that they could increase their training capacity in response to Title IV.

Based on discussions with the RLTCs, asbestos trainers are expected to begin providing lead inspection and abatement training. The transition from asbestos to lead is relatively easy because asbestos training providers are familiar with some of the safety equipment, like respirators, and the work conditions are somewhat similar.

Unions are another expected source of training providers. A number of unions received grants from EPA prior to the formulation of the RLTC network to provide lead abatement training for their members. Unions for painters, industrial painters, and ironworkers are among the most active trainers. However, unions associated with lead-related work are not prevalent in the South and the Midwest. In those regions, national or very large manufacturing companies will occasionally offer lead abatement classes to their workers.

Most of the trainers are certified Industrial Hygienists or Occupational Health Specialists; few trainers have specific backgrounds in lead. Trainers are hired either on a full-time or a consultant basis, and a majority of company owners also teach training classes.

2.1.3 Courses

Courses offered by training providers vary depending on the discipline of training and location of the training facility. Private providers offer courses required under state laws, while RLTCs offer EPA model curricula. Overall, most private providers offer similar courses and course lengths. One major difference is that most Massachusetts certified providers will offer separate contractor and supervisor courses, while non-Massachusetts accredited providers tend to offer a combined course which adheres to the EPA model. In general, private providers offer the following course lengths and tuition rates:

- 2 1/2 or 3-day inspector course: $271-450
- 3-day supervisor course: $249-495
- 4-day contractor course: $349-595
- 2 1/2 or 3-day worker course: $199-400

A few non-Massachusetts based providers offer a 4-day inspector course for $550-575, as well as a combined supervisor/contractor course for $495-695.

There does not appear to be a strong correlation between the number of course days and tuition charged. However, non-Massachusetts providers consistently charged higher rates than Massachusetts providers. Since Massachusetts providers are operating within a more mature market, their tuitions probably reflect the impact of competition and the apparent oversupply of trained individuals.

Exhibit 2.2 briefly outlines the general course content for each discipline offered in Massachusetts. In general, the course contents are cumulative.

2.1.4 Training per Year

The number of persons trained per year was determined using three sources: (1) Massachusetts State Agency information, (2) RLTC information, and (3) private provider information (Massachusetts and non-Massachusetts). Estimates of average total number of persons trained per year varies significantly among the sources.

The Massachusetts Department of Labor & Industries and the Department of Public Health provided information for total licenses/certifications issued in Massachusetts. They reported that in 1994 there were: approximately 337 licensed inspectors, 480 licensed contractors, and 700 certified supervisors. In Massachusetts, contractor training is more extensive than supervisor training, and includes instruction on liability and record keeping. Each year, approximately half of the licenses/certifications issued are new and half are renewals. Therefore, since training is required in order to become licensed/certified, at least 169 inspectors, 240 contractors, and 350 supervisors received training from accredited Massachusetts training providers in 1995.
Exhibit 2.3 summarizes Massachusetts licensing and training information.

During the December 1988 to 1994 period, a total of 1,379 contractor licenses and 3,030 supervisor certifications were issued in Massachusetts. Therefore, the total number of people trained is much higher than the number currently active. Officials from Massachusetts explained the drop in active contractors by indicating that many licensed contractors are homeowners, landlords, or realtors who have decided that it is cheaper to get trained and perform the abatement work themselves, instead of hiring a contractor. The majority of these licensees will allow their licenses to expire after they have abated their own property.

Massachusetts officials believe that the number of active supervisors is less than the total trained for two reasons. First, supervisors can take an additional day of training to become a licensed contractor which allows them to work alone. Second, there is a natural attrition rate involved in both disciplines.

Exhibit 2.2: Massachusetts Training Course Content

Course Name	Course Content
Inspector	- Health effects and medical monitoring - Tenant/owner rights - Notification requirements - Personal protective equipment and respirators - Deleading procedures - Lead inspection methods - Use of XRF - Ethical considerations - Answering tenant/owner questions - History of lead poisoning - Apprenticeship
Risk Assessor	Not required under Massachusetts law and none are offered.
Project Planner	Not Required under Massachusetts law and none are offered.
Supervisor	- Worker course requirements - Supervisor techniques - Reading lead reports - Wipe testing - Air sampling - Reinspecting procedures - Regulatory requirements
Contractor	- Supervisor course requirements - Insurance - Lead abatement costs - Prebid and bidding activities - Respirator protection program - Recordkeeping - Legal activities
Worker	- History of lead poisoning - Work area preparation - Work practices - Personal protective equipment - Health effects and medical surveillance - Equipment training - Abatement methods - Clean-up procedures

As shown in Exhibit 2.3, each training provider trained an average of 14-23 people per discipline in 1995. These numbers indicate that there are more training providers in Massachusetts than the demand for training can support, since training such a small number would not provide a yearly income. Based on discussions with Massachusetts providers, several providers have not offered training classes in some disciplines for several years.

Exhibit 2.3: Total Massachusetts Licenses/Certification and Training in 1994			
	Number of Licenses/ Certifications issued in 1994	**Number of People Trained in 1994***	**Annual Average Number of People Trained per Provider****
Inspector	337	169	14
Contractor	480	240	16
Supervisor	700	350	23

* Based on information provided from Massachusetts officials stating that half of each year's licenses/certifications are new issues, half are renewals. Training is required to receive a new license.

** Based on information provided from Department of Labor & Industry and Department of Public Health. Averages calculated based on 12 inspector training providers and 15 supervisor, contractor, and worker training providers accredited by the state of Massachusetts (see Exhibit 2.1).

Therefore, those who did offer classes probably trained more than the average of 14-23 people.

Nine RLTC consortia members provided information on total training per discipline in 1992. There was a significant range, especially for the contractor/supervisor, risk assessor, and inspector courses. The centers reported between 26-220 total trained for the contractor/supervisor course, between 26-224 total trained for the inspector course, and between 12-192 for the risk assessor course. Georgia-Tech reported the high end of the range for all three disciplines. Exhibit 2.4 provides a summary of this information.

2.1.5 Average Class Size

Based on interviews with four private training providers located in four states, enrollment for inspector training has remained constant over the past couple of years, while enrollment for contractor, supervisor, and worker (target housing and superstructures) courses has increased by about 20 percent. One provider felt that the demand for training was "increasing as the public becomes more aware of the hazards of lead." Another provider indicated, however, that they used to have 40 people in a class, where now they have 10 people. This decline may be a result of (1) more trainers entering the market or (2) a drop in the overall demand for training.

Most of the RLTC's have an average class size of between 15-55 students per discipline depending on the location of the center. There are no major differences in average class size between the disciplines. The RLTCs indicated that at least 15-20 students per course are needed to break-even on costs. Private providers indicated a break-even point of only 6-10 people. Both private providers and RLTCs indicated that despite an increase in

Exhibit 2.4: Total and Average RLTC Training, 1992

Provider	Inspector	Risk Assessor	Project Planner	Contractor/ Supervisor	Worker
Georgia Tech	224	192	24	220	-
University of California - San Diego	68	-	-	95	-
University of Massachusetts - Amherst	215	-	-	71	2
University of Cincinnati	36	-	-	54	-
University of Kansas	170	-	-	128	-
University of Illinois	26	-	-	68	-
University of Minnesota	54	-	-	26	-
University of Maryland	32	12	-	96	-
Cleveland Department of Health	-	-	-	48	18
Distribution:					
High	224	192	24	220	18
Mean	103	102	24	90	10
Low	26	12	24	26	2

demand for most courses; they are opening at well below capacity, frequently not breaking even on costs.

2.1.6 Estimated Revenue from Tuition

In addition to lead training, most providers obtain some revenue from training courses in other occupational areas, such as asbestos training, OSHA hazard communication, underground storage tank removal, occupational respiratory protection, and even some first aid and CPR. Most private providers rely exclusively on tuition for their revenue, while the RLTCs and consortia members received an estimated $2.4 million for a two-year period starting in 1994. An estimate of the total EPA grant money received by the RLTCs is unavailable for this analysis. Revenue from tuition for private providers and RLTC's is calculated in Exhibit 2.5. There is a significant range in the revenues earned by the RLTCs. As shown, Georgia-Tech earned an estimated $437,320 in lead-based paint training tuition revenue in 1992, while the University of Minnesota earned only $46,500. In each discipline, Georgia-Tech earned over 50 percent more revenue than the next largest RLTC or consortia member, and over 100 percent more in total for the year.

On average, private providers earn less than the RLTCs. Private firms' earnings from lead-based paint training ranged from $8,700 to $133,200, with the low earning provider only offering superstructure worker training. A list of tuitions charged by various private training providers is presented in Appendix 2.A.

2.1.7 Seasonality

Based on conversations with lead training providers, the summer season is the slowest time for training because summer is the busiest time for the construction industry. Conversely, construction work is slowest in the winter, therefore allowing time for training.

2.2 Markets for Abatement Services

The lead abatement industry has developed, in large part, as a result of the recent concerns about lead poisoning of children. Since the beginning of the 1990s, the number of lead abatement firms has increased due to the initiation of childhood lead poisoning prevention statutes by several states. Many firms involved in other construction activities, most notably asbestos abatement work, expanded to include lead abatement work (White, 1993).

Lead abatement is essentially composed of the removal or encapsulation of lead-based paint, removal of building components coated with lead-based paint, and removal of dust or chips from lead-based paint. In the short history of the lead-based paint industry, three primary markets have been characterized: public and private residences, steel superstructures, and public/commercial buildings. Industry representatives maintain that the majority of abatements taking place today are in public multi-family dwellings, while single-family publicly-owned dwellings are being abated from lead at a lesser rate. Lead abatement work for public/commercial buildings has occurred at an almost negligible rate (Zilca, 1993).

Exhibit 2.5: Estimated Revenue from Tuition, 1992

	Inspector	Risk Assessor	Project Planner	Contractor and/or Supervisor	Worker	Steelstructure — Contractor	Steelstructure — Worker	Total Revenue From Tuition
RLTC								
Georgia-Tech	$150,080	$128,640	$15,600	$143,000				$437,320
U of California - San Diego	37,400			61,750				99,150
U Mass - Amherst	96,750			31,950	750			129,450
U of Cincinnati	18,000			40,500				58,500
U of Kansas	98,430			95,872				194,302
U of Illinois	15,470			45,900				61,370
U of Minnesota	27,000			19,500				46,500
U of Maryland	17,325			60,000				77,325
Cleveland DEH				33,360				Unavailable
Private[2]								
Firm A				39,000	6,250			45,250
Firm B	13,500			35,000	64,900	19,800		133,200
Firm C	6,900			8,720				15,620
Firm D							8,700	8,700

[1] See Exhibits 2.4 and 4.12 for total training numbers and tuition costs.
[2] Based on survey from four training providers.

2.2.1 Residential Lead Abatement Firm Profile

The process of residential abatement work consists of three components: inspection, lead abatement, and post-abatement clean-up. Inspection (which, in the current market, includes a risk screen) is necessary to ascertain the location and concentration of lead within a space for a prospective abatement. The abatement process involves four different procedures which can be implemented separately or in combination. One of the most prevalent procedures is the removal of lead-based paint. This procedure is commonly done for single-family dwellings and other smaller jobs. For large-scale jobs, lead-based paint can be sealed to prevent lead exposure by either encapsulating the surface with special resins or encasing the surface with drywall, or in exterior work with aluminum or vinyl siding. The third abatement procedure is the replacement of lead-based paint covered items, such as doors and window trim. Replacement is frequently employed in tandem with either of the first two abatement procedures. The last type of abatement practice is referred to as in-place management of lead-based paint. This consists of interim controls of lead exposure, such as washing walls and vacuuming enclosed spaces. After abatement, the lead abatement firm will remove and dispose of the lead-contaminated materials. Disposal of lead abatement wastes sometimes requires the use of a hazardous waste treatment, storage, and disposal (TSD) facility, usually under contract with the lead abatement firm.

The number of personnel in a lead abatement crew depends in part on the size of the job. However, industry contacts have stressed the importance of diversity in the work crew to include a supervisor, specialty workers (such as carpenters, tile layers, and drywall technicians), and laborers. For small- to medium-size jobs, the typical crew will consist of three to four persons: one supervisor, one specialist, and one or two workers. Larger jobs necessitate more persons for a crew: one supervisor, two specialists, and two workers. In general, industry experts feel that knowledge of carpentry is essential for performing abatements. As a result, carpenters are contracted or hired onto many lead abatement crews; in addition, many supervisors are licensed carpenters. Some supervisors will not participate in abatement, but will serve as a project monitor to ensure workers are properly protected against lead exposure.

Costs The costs for a typical residential lead abatement firm will include equipment, materials, wages, and insurance. A standard set of equipment and materials (such as that recommended by the Occupational Safety and Health Administration (OSHA)) are used, including work environment control equipment, construction tools, protective work clothing, and respiratory protection equipment. Safety equipment can be expensive. For example, an abatement firm would have to invest close to $10,000 for HEPA vacuum equipment to initiate a residential abatement project (OSHA, 1993, Chapter 6). Wages for on-site crew members vary depending on region of the country and skill-level. Insurance costs for the lead abatement industry can be significant; one lead abatement contractor spends 12 percent of his annual anticipated receipts on insurance (Mitchell, White, Zilca).

Fees and Profits The fees for lead abatement vary broadly across the country depending on the size of the project. Apartment housing units are generally less expensive to abate because they are usually smaller in cubic space. The costs to abate apartments of lead will range from $2,300 to $5,000 per unit, depending on the part of the country in which the abatement takes place. Abatements for single family housing tends to be more expensive than apartment housing. In addition, there is a higher variance of prices for private housing abatement due to the wider diversity in size and structure. Industry estimated a range of $4,000 to $12,000 for lead abatement (Mitchell, White, Zilca).

Profit margins for the lead abatement industry are significantly higher than other construction practices. This wide margin is a result of the inherent risk in removing lead. Industry contacts estimated that profits range from 33 percent to 52 percent, however profit margins are likely to decrease with increased competition as a result of new regulations (Mitchell, White, Zilca).

2.3 Substitutes for Lead Paint Abatement

Under this regulation, "abatement" means any measure or set of measures designed to eliminate lead-based paint hazards. Abatement includes permanent or relatively permanent measures such as the removal of lead-based paint and dust, containment or encapsulation of lead-based paint, replacement of lead painted surfaces or fixtures, and removal or covering of lead contaminated soil. In all cases, the design life should be at least 20 years. Abatement also includes all preparation, clean-up, disposal, and post-abatement clearance testing activities associated with such measures.

While the durability of some encapsulating materials, such as gypsum dry wall and exterior siding is well known, some forms of encapsulants are considered to be only interim controls. In all cases, quality installation is critical to its effectiveness; in particular, seams must be sealed to prevent the escape of lead dust. Encapsulants require periodic inspection and may require routine maintenance.

While interim controls are not regulated under §402, they frequently are an appropriate response to the presence of lead-based paint hazards. Interim measures include in-place maintenance, such as thorough washing or wet mopping of surfaces with high phosphate cleaning solutions. Normal vacuuming may simply stir-up the lead contaminated dust since the particles are very small.

2.4 Existing Regulations

Several federal and state agencies have addressed the problems of lead exposure resulting from lead-based paint. The resulting regulations focus on both exposure to lead in the general population as well as occupational lead exposure. Major lead poisoning prevention programs have been implemented by the Consumer Product Safety Commission, the Department of Housing and Urban Development (HUD), the Environmental Protection

Agency (EPA), the Occupational Safety and Health Administration (OSHA), as well as by several states.

In 1978, the Consumer Product Safety Commission established a maximum lead content in paint of 0.06 percent, under Sections 8 and 9 of the Consumer Product Safety Act (15 U.S.C. 2057 and 2058). This standard applies to products intended for use by children, such as toys and playthings, as well as consumer products, such as furniture. In addition, it targets products to which consumers would be exposed after sale, such as paints used in residences, hospitals, schools, playgrounds, and public buildings (42 FR 44199).

In recent years, HUD has addressed the issue of worker protection in the presence of lead-based paint. In 1990, HUD published worker protection guidelines regarding identification and removal of lead-based paint from Public and Indian housing (55 FR 39874). Included in the guidelines is a section on safe working procedures during lead paint abatement, standards for performing inspections and abatements, and mandatory worker education and training. HUD has also developed lead-based paint "in-place management" strategies to serve as preventative measures to lower the risk of full-scale abatement (57 FR 28933). Recently, HUD published proposed rules concerning lead-based paint hazard notification, evaluation, and reduction for federally owned residential property and housing receiving Federal assistance (FR June 7, 1996, p.29170ff).

EPA has administered several initiatives to ensure environmental safety from hazardous exposures to lead. These include regulations for the disposal of substances considered hazardous and toxic. RCRA requires that lead-containing debris be treated to below five parts per million (5 ppm) before disposal (40 CFR 268). This represents a significant amount of waste when considering the disposal of lead-based paint material removed from highway bridges. As a result, several states have initiated equipment practice standards, such as the use of recycling paint-removal machines, when bridge cleaning and repainting operations are performed. Connecticut, Maryland, Massachusetts, Michigan, New Jersey, New York, North Carolina, Ohio, Virginia, and West Virginia have already instituted such measures.

OSHA has regulated lead exposure in general industry since 1978 (29 CFR 1910.1025). These regulations have been revised a number of times, most recently in January, 1990. On May 4, 1993, OSHA promulgated interim final standards governing occupational lead exposure in the construction industries, which were not covered in OSHA's general industries rulings. These regulations set permissible exposure limits. In addition, they require engineering and administrative controls as well as worker practices, exposure monitoring, training, and other ancillary controls. Much of the rule addresses the removal of lead-based paint under various construction activities for residential housing. These projects include: renovation and remodeling, demolition, repainting, maintenance, rehabilitation, and in-place management.

In recent years, the problems of lead exposure have become a major issue in state legislatures. The number of states that have implemented lead poisoning prevention statutes has increased significantly since 1990. Many of these states have included certification and training standards, as well as specific blood-level and lead paint content standards, as major components of their legislation (see Exhibit 2.6). In June 1995, seventeen states had initiated or are in the process of setting accreditation and training standards for inspectors, supervisor and contractors, and/or workers. This group of states includes Alaska, California, Connecticut, Georgia, Illinois, Louisiana, Maine, Massachusetts, Minnesota, Missouri, New Hampshire, Ohio, Pennsylvania, Rhode Island, Vermont, Virginia, and Wisconsin. Additional states are considering such legislation.

Exhibit 2.6

State Lead Poisoning Prevention Statutes as of June 1995

State	**State Definitions of Lead-Based Paint (LBP) and Elevated Blood Levels (EBL)**	**Accreditation and Abatement Measures**
Alaska		-Accreditation of professional painters who perform hazardous painting work
Arizona	-LBP is 5/10 of 1% by weight of lead metal. -Required reporting by physicians of blood/level above 25 ug/dl.	
Arkansas	none defined	-Allows state to require abatement of LBP in dwellings where kids have been identified with EBL.
California	-EBL over 25 ug/dl (may be lowered to 15 ug/dl).	-Certification is now required for contractors, inspectors, and workers -Accreditation program implemented through general departmental authority. -Requires the establishment of environmental abatement procedures and the adoption of regulations for abatement of LBP in and on housing. -Imposes a fee on manufacturers and other persons involved with the production or selling of lead or LBP products.
Connecticut	- EBL is 0.25 ug per 100 grams of blood.	-Accreditation of contractors is available, but not required -Financial assistance for removal of lead-based paint and asbestos. -Inspection of day-care centers. -Upon the receipt of EBL report, the state has the authority to investigate the source of the lead.
Delaware		-Prohibits the use of paint with more than .5% lead on any surfaces of a dwelling or dwelling unit, including fences and outbuildings.

Exhibit 2.6

State Lead Poisoning Prevention Statutes as of June 1995

State	**State Definitions of Lead-Based Paint (LBP) and Elevated Blood Levels (EBL)**	**Accreditation and Abatement Measures**
District of Columbia		-Requires residential premises with children under 8 to maintain the property free of lead or lead in amounts less than 0.7 milligrams per cm^2. -Authorizes District to order abatement or elimination of lead hazard by other approved means within 10 days and in no more than 30 days. -Authorizes District to inspect any residential premises where there is reason to believe lead may present a health hazard to a child under 8 years.
Florida		-Prohibits employment of persons under 15 yrs. to work with LBP.
Georgia	-lead poisoning is reportable at 10 ug/dL -lead based paint is paint with lead in excess of limits established by the Department of Natural Resources -lead contaminated soil, dust and waste is defined as in excess of limits established by the Department of Natural Resources	-Lead hazard reduction activities must be done by licensed and/or certified individuals after 1996 (lead hazard reduction is defined the same as Title X). -Licensing and certification requires training by a state accredited training provider.
Illinois	-'lead-bearing substance' is 5/10 of 1% lead by weight (or lower standard)	-Requires the accreditation of lead-abatement inspectors, contractors and workers and state-approval of training providers -Authority to investigate sources of lead in dwellings, require owner to remove, replace, or secure a covering over the lead-based substance.
Iowa		-Coordinate a lead abatement program with the U. of Iowa and the Dept. of Nat. Resources.
Kentucky	-'lead-based substance' is more than .06% lead by weight. -EBL is 25 ug/dl or greater	-Authority to inspect sources of lead poisoning, demand the removal, replacement, or securing of lead-based surfaces. -Prohibits paint w/more than .5% lead by weight.

Exhibit 2.6

State Lead Poisoning Prevention Statutes as of June 1995

State	**State Definitions of Lead-Based Paint (LBP) and Elevated Blood Levels (EBL)**	**Accreditation and Abatement Measures**
Louisiana	-LBP contains more than .5% lead by weight.	-Requires owners to remove or cover paint, plaster, or other accessible lead-based materials if a child under 6 years or if a mentally retarded person resides at the premises. -Licensure and certification requirements for lead abatement and inspection professionals -Abatement provisions
Maine	-LBP contains more than .5% lead by weight.	-Very close to passing training and accreditation legislation -Authority to inspect dwelling units to ascertain the presence of lead, and order the removal, replacement or covering of the lead-based materials.
Maryland		-Prohibits the use of LBP on any interior or exterior surface commonly accessible to children. -Provides for lessee of a rental property to deposit rent at General Court if lessor has not removed lead within 20 days of notice. -Immunity from liability for owners who meet certain requirements and under certain conditions.
Massachusetts	-Prohibits use of paint with more than 6/100 of 1% lead by weight.	-Requirement of the owner of a residential premises to remove or cover lead-based materials to make them inaccessible to kids under 6 years. -Licensing for persons who inspect or abate lead -Certification for private laboratories. -Authority to revoke, suspend or cancel licenses.

Exhibit 2.6

State Lead Poisoning Prevention Statutes as of June 1995

State	State Definitions of Lead-Based Paint (LBP) and Elevated Blood Levels (EBL)	Accreditation and Abatement Measures
Minnesota	-Risk assessments for blood lead over 25 ug/dl;	-Registration for abatement contractors. -Development of residential abatement guide. -Requirement for owners to abate if lead sources exceed the standards if children under 6 years or pregnant women with blood/lead levels over 10 ug/dl reside there.
Missouri		Legislation enacted to provide for licensure and accreditation of lead abatement and inspection professionals, enforcement authority, establishment of blood lead levels.
New Hampshire	-LBP defined by federal standards	-Prohibits the use or application on any dwelling unit or child-care facility of LBP. -Provisions to inspect dwellings or child care facilities only where there is reasonable grounds to do so. -Licensure of lead abatement personnel. -Provides for notification of owners/occupiers of lead hazards.
New Jersey	-LBP is defined by the total nonvolatile ingredients containing more than 1% lead by weight.	-If an individual has lead-poisoning, abatement must be done within 10 days. -Requires promulgation of regulations that identify sources of lead within dwellings, to establish testing procedures to detect lead in individuals. -Provides state authority to order abatement within 10 days if an individual in the unit is suffering from lead poisoning.
New York	-LBP contains more than 1/2 of 1% lead by weight on any interior surfaces or window frames or porches on any dwelling.	-Regulation of abatement including notification to owner/occupant in areas of high risk to discontinue use of LBP

Exhibit 2.6

State Lead Poisoning Prevention Statutes as of June 1995

State	State Definitions of Lead-Based Paint (LBP) and Elevated Blood Levels (EBL)	Accreditation and Abatement Measures
North Carolina		-Abatement of lead poisoning hazards in dwelling, schools, and day care facilities determined to be a source of EBL in children less than 6 years.
Ohio		-Provides for the licensure of person performing lead abatement work and the approval of environmental lead laboratories. -Clinical laboratories and physicians required to report the results of lead screening tests to the Dept. of Health. -Individuals involved in lead inspection and abatement industry required to be licensed. -Director of health or local boards of health may inspect structures for lead upon the report of EBL in a child.
Pennsylvania		-Funds will be used to train weatherization crews in lead paint abatement for low-income housing containing lead-poisoned kids.

Exhibit 2.6

State Lead Poisoning Prevention Statutes as of June 1995

State	State Definitions of Lead-Based Paint (LBP) and Elevated Blood Levels (EBL)	Accreditation and Abatement Measures
Rhode Island	-'Lead-based substance' is material containing lead in excess of .5% lead by weight.	-All lead samples will be analyzed at a Dept. of Health lab. -Lead inspectors and lead hazard reduction workers be licensed or certified and training courses be certified by DOH. -DOH to develop educational materials to realtors -Inspections be authorized as part of treatment and follow-up for lead poisoned children. -Regulations for safety procedures for lead hazard reduction workers, and the creation of at least one lead paint waste repository. -All preschools, kindergartens, day care, nursery schools be lead-free or lead-safe as a condition of licensure. -Prohibits state funds to be used for projects unless the contractor has complied with state's training and certification standards and OSHA's standards
South Carolina	-'Lead-based substance' as surface-coating material containing more than 6/100 of 1% lead by weight.	-Reports of lead to the state which will perform its own inspection and identify areas in need of correction. -Requires owner to remove or cover lead hazards within 30 days.
Vermont		-Training and certification program for lead hazard abatement workers. -Blood screening on request. -Disclosure of lead-based hazards prior to sale or lease of pre-1978 housing. -Inspect and test child care facilities.
Virginia		-Training and certification program for lead hazard abatement workers. -Program must meet federal standards (i.e., model state programs).

Exhibit 2.6

State Lead Poisoning Prevention Statutes as of June 1995

State	**State Definitions of Lead-Based Paint (LBP) and Elevated Blood Levels (EBL)**	**Accreditation and Abatement Measures**
Wisconsin	-LBP contains more than .06% lead by weight. -EBL is over 25 ug/dl	-Received HUD grant for lead abatement and it requires certification and/or provision of training of contractors, inspectors, and workers -Inspections for all dwellings identified as sources of lead poisoning -Requires removal or covering of lead within 30 days. -Comprehensive screening and medical case management. -Mandatory insurance coverage in certain circumstances.

Source: National Conference of State Legislatures.

Appendix 2.A

Private Training Provider Tuition Costs

Appendix 2.A: Private Training Provider Tuition Costs, October 1992

Name	State(s) Accredited in	Inspector Technician	Inspector Risk Assessor	Project Designer	Supervisor/ Contractor	Contractor	Supervisor	Worker	Other
Pro-Tech	MA	$463							
Mayhew Environmental Training	KS, MA					$595	$495	$325	
Cal Inc.	CA	$575		$575	$545			$400	1st day prerequisite $150; lead awareness $150; Superstructure supervisor $545, worker $400; Refresher courses $150.
Vortex Inc.	RI, MA	$350				$350	$300	$250	
Aulson Co.	MA, CA	$400				$450	$325	$275	Inspecting and Abating Lead-Based Paint $600.
Environmental Training Services	MA	$271				$349	$249	$199	
Dennison Environmental Inc.	MA	$425				$425	$325	$275	
I.E.E.	MA	$395				$375	$300	$250	
Lead Busters Institute	MA	$400				$390	$290	$250	
Lead Solutions	CA	$550			$500			$375	Combined Inspectors/Contractors-Supervisors 7-day program, $790.
Quality Control Services	MA	$295				$375	$275	$250	
Mystic Air Quality	MA, CT	$375			$500			$375	Annual refresher courses $120
Leadtec Services	MD		$395 (MD) $550 (IL)		$695 (NJ), $600 (NY), $495 (MD), $550 (NY)				
Tufts University	MA	$475				$525	$425	$375	
Con-Test	MA	$450				$495	$350	$300	Superstructure Contractor $495 days)
Average Tuition:									
All Providers		$417	$473	$575	$555	$426	$333	$300	
Massachusetts Providers		$391	-	-	$500	$426	$333	$284	

[1] Information obtained from company brochures.

3. DEFINITION OF THE PROBLEM AND REGULATORY OPTION

The primary purpose and impact of TSCA §402(a) and 404 is to require that all lead paint activities[1] be performed by personnel certified as trained by an accredited training program, and that all lead paint activities meet certain minimum work practice standards.[2] Section 402 does not affect the quantity (i.e., number) of lead paint activities that will occur in the future (except indirectly through the effect of changing the price of lead paint activities). Therefore, total reductions in exposure and risk resulting from a housing abatement are not the result of §402. However, the training requirements and work practice standards are likely to provide improved identification of lead-based paint hazards and to better prevent lead exposure during abatements than current practices, resulting in an increase in the benefits resulting from each lead-based paint activity. In other words, the potential incremental reductions in human exposure and ecological risk due to §402 will be in addition to the benefits of abatements as they are currently performed. As described more fully later in this chapter, poorly performed abatements can result in increases in exposure. These regulations will greatly reduce, or eliminate, these poorly performed abatements while also improving the performance of the other activities. Further, §402 may provide incremental reductions in occupational exposure beyond the level provided by other occupational exposure regulations. People who may receive exposure and risk reductions from the rule are:

- Residents of houses during, and immediately following, abatement due to requirements to prepare an occupant protection plan before abatement and to clean up lead contaminated dust and debris from the abatement site.

- Current and future residents of abated homes long term exposure to lead from paint due to identification and proper permanent abatement of lead paint hazards in the home.

- Additinal reductions of occupational exposure (beyond that provided by OSHA worker protection regulations) to lead hazards by lead-based paint abatement workers, as a result of training in, and adherence to, work practice standards for inspections, assessment, and abatement procedures.

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[1]Section 402(b) separates "Lead Based Paint Activities" into two groups: housing abatement related activities (inspection, risk assessment and abatement) and "Deleading". Deleading is defined as eliminating the lead paint hazards associated with paint removal from public and commercial buildings, bridges and other structures, or the lead paint hazards associated with the demolition of such buildings and structures. This RIA deals with the rules affecting target housing and child-occupied facilities.

[2]References to Section 402 include §402(a) and 402(b) only. Section 402(c) deals with renovation and remodeling activities and will be covered by a separate rule.

- Other people who live, work or travel near to abatement activities due to all abatement activities being performed by trained workers following the work practice standards.

In addition, possible ecological damage resulting from lead exposure may be avoided due to the work practice standards including proper containment and clean-up requirements.

3.1 Hazard, Exposure and Risk Summary

The toxicity of lead and lead compounds has long been established as a dangerous threat to human health and wellbeing that often goes unrecognized by people exposed to potentially harmful levels of lead. Because of the concern about lead's threat to public health, federal regulations have already addressed several of the major uses of lead that result in high levels of human exposure. For example, the use of lead in gasoline, residential paint and food containers has already been phased out. The EPA and other federal agencies are pursuing opportunities for further progress in reducing lead exposure from current consumption of goods and services. One of the largest remaining sources of lead exposure, especially in children, is from lead-based paint. Although the use and manufacture of lead-based paint for residential purposes declined after World War II, and was banned[3] in 1978 by the Consumer Product Safety Commission, many older residences still contain paint with a high lead content. Significant current lead exposure occurs directly because of the continued presence of old lead-based paint, especially if the paint (or the surface it is applied to) is deteriorating. Chronic exposure to even small amounts of lead can result in a large long-term accumulation in children and adults. In 1991 the Centers for Disease Control concluded that lead-based paint remains the most common high-dose source of lead exposure for pre-school aged children in the United States. In addition, there are known adverse health effects at much lower levels of lead accumulation.

This section summarizes both the human health hazards from lead (the available dose-response functions are shown in Appendix 7A), and discusses the changes to exposure and risk associated with TSCA §§402 (a) and 404. Although it is possible to estimate some of the effects of reducing the body's lead burden in infants, children, and adults, it is not possible at this time to quantify the incremental changes in exposure, uptake, body burden and resulting risk from implementing the standards and training requirements for abatement activities. Section 3.1.1 provides a summary of the health effects of lead for the populations of concern, Section 3.1.2 provides a discussion identifying the exposed populations, how exposure occurs, and how TSCA §§402 (a) and 404 will affect the exposure. Estimates of the amount and value of these benefits are presented in Chapters 6 and 7.

[3]The CPSC banned the use of paint containing more than 0.06% lead by weight on interior and external residential surfaces, toys and furniture. Paint with a lead content below this level is referred to as lead free paint.

3.1.1 Hazard and Dose-Response Summary

EPA has conducted numerous studies on the health effects associated with lead exposure. In a pioneering study, Schwartz et al. (USEPA 1985) quantified a number of health benefits that would result from reductions in the lead content of gasoline. The work was extended by EPA's analysis of lead in drinking water (USEPA 1986) and by an EPA-funded study of alternative lead National Ambient Air Quality Standards (USEPA 1987). Despite this substantial research, much uncertainty remains. Many categories of health effects from lead exposure cannot be quantified because credible dose-response functions are not yet available. For those health effects that can be quantified, economic research does not always allow complete valuation of the willingness to pay to avoid the effects.

The literature discussing the number and severity of health effects associated with elevated lead exposure is widely available and will not be discussed in detail here.[4] While lead is harmful to any exposed individual, USEPA (1990) identifies three sensitive population groups based on available information: pregnant women (principally as exposure surrogates for the fetus), pre-school age children, and adult men and women. Some of the health benefits that might result by reducing lead exposures are listed in Exhibit 3.1.

Health Hazards to Infants Less Than One Year Old USEPA (1990) cites a number of studies linking fetal exposure to lead (via in utero exposure from maternal intake of lead) to several adverse health effects. These effects include decreased gestational age, reduced birth weight, late fetal death, and increases in infant mortality. The Centers for Disease Control (CDC, 1991) estimated the risk of infant mortality decreases by 10^{-4} (or 0.0001) for each 1 μg/dL decrease in maternal blood lead level during pregnancy. It is also believed that neurobehavioral deficits in infants may result from both pre-natal and early post-natal exposure. Other metabolic effects, as described for children below, have also been identified in infants. Quantification of these effects is possible because sufficient data exist to estimate dose-response relationships and the clinical significance of the IQ effect is clear.

Health Hazards to Children Between One and Six Years Old Elevated levels of blood lead in children may induce a number of metabolic effects such as impaired heme synthesis, anemia, slowed growth, and cancer (USEPA 1990). Severe lead poisoning may result in seizures, incoordination, recurrent vomiting, coma, and acute lead encephalopathy, a potentially fatal condition (Piomelli et al. 1984). Elevated lead exposure may also induce a number of effects on the human nervous system. Generally, these neurobehavioral effects are more serious for children than for adults because of children's rapid rate of development. These nervous system effects may include hyperactivity, behavioral and attentional difficulties, delayed mental development, and motor and perceptual skill deficits. Quantification of this effect is possible because a dose-response relationship for IQ decrements has been previously estimated (Schwartz, 1993).

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[4]For a detailed review of this literature see U.S. Environmental Protection Agency, (1986) *Air Quality Criteria Document for Lead*, and 1989 Addendum. Environmental Criteria and Assessment Office, Office of Research and Development, March.

Exhibit 3.1
Health Hazard Categories Associated With Reducing Lead Exposure

<u>Infants < 1 Year old</u>

- Neonatal mortality from decreased gestational age
- Fetal effects from maternal exposure, including diminished childhood IQ and reduced birth weight
- Reduced intelligence from first year post-natal exposure
- Other neurological and metabolic effects as for children

<u>Children < 7 Years Old</u>

- Interference with growth
- Reduced intelligence
- Impaired hearing, behavioral changes
- Interference with nervous system development
- Metabolic effects, impaired heme synthesis, anemia
- Possible Cancer

<u>Adult Men</u>

- Hypertension in adults
- Non-fatal heart attack and non-fatal stroke in adults
- Premature death from all causes in adults
- Possible Cancer

<u>Adult Women</u>

- Hypertension
- Non-fatal heart attack and non-fatal stroke
- Premature death from all causes
- Reproductive effects
- Possible Cancer

Health Hazards to Men Elevated blood lead has been linked to elevated blood pressure in adult males, especially men of ages 40-59 years (Pirkle et al. 1985). Further studies have demonstrated a dose response relationship for hypertension (defined as diastolic blood pressure above 90 mm Hg for this report) in males aged 20-74 years (Schwartz 1988). Because blood pressure has been identified as a risk factor in a number of cardiovascular illnesses (Shurtleff 1974, McGee and Gordon 1976, Pooling Project 1978), it is useful to quantify the effect of changes in blood lead levels on changes in blood pressure for reasons other than predicting the probability of hypertension. The relationship between blood pressure and other health effects can be used to predict increased probabilities of the initial occurrence of heart attack and stroke (USEPA 1987). These blood pressure changes can be used to predict the probabilities of first-time heart attacks and strokes. Increased blood pressure would also increase the probability of reoccurrences of heart attacks and strokes, but these quantified relationships are not available. Citing laboratory studies with rodents, USEPA (1990) also presents evidence of the genotoxicity and/or carcinogenicity of lead compounds. While such animal toxicological evidence suggests that human cancer effects are possible, dose-response relationships are not currently available.

Health Hazards to Women Some available evidence suggests the possibility of health benefits from reducing the exposure of women to lead. Recent expanded analysis of data from the second National Health and Nutrition Examination Survey[5] (NHANES II) by Schwartz (1990) indicates a significant association between blood pressure and blood lead in women. Another study, by Rabinowitz et al. (1987), found a small but demonstrable between maternal blood lead and pregnancy hypertension and blood pressure at time of delivery.

Elevated blood pressure in women results in the same effects as for men (the occurrence of heart attack, two types of stroke, and premature death). However, the general relationships between BP and these health effects are not identical to the relationships for men. Lead toxicity is also believed to have reproductive effects through increased rates of miscarriage and stillbirth (Oliver 1911 as cited in USEPA 1990). A study of NHANES II data by Silbergeld et al. (1988) suggests that accumulated lead stores in the bone tissues of women may be mobilized into blood during conditions of bone demineralization associated with pregnancy, lactation and osteoporosis. The authors note that "lead may interact with other factors in the course of postmenopausal osteoporosis, to aggravate the course of the disease, since lead is known to inhibit activation of vitamin D, uptake of dietary calcium, and several regulatory aspects of bone cell function." No quantitative relationship has yet been established, however, between lead stores in women and postmenopausal health endpoints. Increased cancer risk in women of elevated lead exposure is also possible based on animal toxicology studies.

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[5] The Second National Health and Nutrition Examination Survey (NHANES II) was conducted by the U.S. Department of Health and Human Services from 1976 to 1980 and provides researchers with a comprehensive set of nutritional, demographic and health data for the U.S. population.

3.1.2. Exposure Summary

The §402(a) inspector, risk assessor and abatement worker training and work practice standards apply to lead paint abatement in residences and child-occupied facilities. Three different sub-populations are potentially affected by these activities: residents, labor engaged in the lead paint activities in one way or another, and other people who live, work or travel near to a site where lead paint is abated. Ecological impacts are also possible, although this is not probable in residential and child-occupied facilities where the work is unlikely to be on the exterior.

Published medical and public health literature provides compelling anecdotal evidence of lead toxicity associated with poorly performed abatements. However, insufficient information is available at this time to quantitatively assess the full exposure (and hence the risk) reductions directly associated with §402. While case study information is available on the current exposure and risk to certain groups potentially affected by this regulation, the information does not fully reflect the baseline exposure for all of the affected populations. In addition, information on the marginal exposure reduction directly associated with the §402 certification and work practice standards is not available. This section identifies the populations potentially affected by these regulations, and describes how they may be affected.

Residents Lead-based paint (containing up to 50 percent lead by weight) was in widespread use through the 1940's. Indoor use of lead-based paint declined beginning in the 1950's until residential lead-based paint was banned in 1978, but lead-based exterior paint continued to be relatively common until it was banned. More than 3 million tons of lead-based paint is believed to still be in place in the housing stock, especially in homes built before 1950. While the year of construction is one important indicator of which housing units have high lead paint levels, jointly considering the paint's lead content and condition provides a more direct measure of potential exposure and risk. Exhibit 3.2 shows the distribution of the 1990 stock of all non-publicly owned housing units in the United States built before 1980 by lead paint levels and paint condition.[6] The lead paint measure used in this report is the maximum amount of lead contained in paint on interior surfaces. The lead paint load is typically measured in units of mg/cm^2. Condition is measured as the percentage of lead painted surface area that is damaged in the area with the greatest interior lead paint damage in a given home. The information in Exhibit 3.2 is based on the National Survey of Lead-based Paint in Housing by the U.S. Department of Housing and Urban Development. The survey results have been extrapolated to the entire national private housing stock.

Lead paint in place in a home creates a potential lead exposure problem because of inhalation and ingestion of paint chips and dust containing paint residue. Lead paint is more commonly found on doors and windows, rather than on walls. Paint that is in poor condition

[6]The term "target housing" is defined in Title X as housing constructed prior to 1978. Data limitations, however, require the use of pre-1980 housing stock.

Exhibit 3.2 Distribution of Lead Levels and Paint Conditions in 1990 Non-publicly Owned Housing Stock Built Before 1980			
Maximum Lead Level (mg/cm^2)	**Paint Condition (Percent of surface area damaged)**		
	Intact - 10%	**10-100%**	**Total**
>12	1,746,284	0	1,746,284
>10 and ≤12	237,667	1,166,636	1,404,303
>8 and ≤10	718,070	1,563,087	2,281,157
>6 and ≤8	2,181,464	688,403	2,869,867
>4 and ≤6	687,638	378,831	1,066,469
>2 and ≤4	3,261,889	1,041,389	4,303,278
>1 and ≤2	8,896,375	819,316	9,715,691
≤1	46,972,538	6,819,433	53,791,971
Total:	64,701,925	12,477,095	77,179,020
Source: U.S. Department of Housing and Urban Development (1990).			

(e.g., chipped, cracked or peeling) or on surfaces that are deteriorating can result in significant exposure, but even intact paint can contribute to increased dust levels. Lead contaminated dust can be steadily released from painted surfaces that are subject to repeated abrasion; these friction surfaces include floors, door frames, and window sills.

Hand-to-mouth activity is the major source of uptake, especially in children, although cases of severe lead toxicity have been attributed to pica (repeated deliberate ingestion of non-food substances). Hand washing (especially before eating) and routine household cleaning and maintenance can reduce the exposure to lead from paint.

Despite the good intentions of people performing lead paint abatements in an attempt to lower the hazard to children from lead-based paint, recent reports indicate that the abatement often has the undesired effect of increasing, at least temporarily, the child's blood lead. Abatements that increase the household dust content are particularly hazardous for children, as hand-to-mouth activity is a major route of entry of lead into the body and because absorption of lead is inversely proportional to particle size. Farfel and Chisolm (1990) report some remarkable findings from a study that monitored the blood lead of children under 24 months of age before and after lead abatement activities in their homes. The study compared the lead exposure (measured both as dust content and blood lead levels) resulting from "traditional" abatement (torch and/or sander removal, no repainting, minimal clean-up and minimal protection for workers, residents or household objects) and "modified abatement" (using a heat gun, clean-up with thorough debris disposal, and at least some protection for workers, residents and household objects). While the modified abatement used improved techniques compared with the traditional abatements, the modified techniques in the study are not as rigorous as the work practice standards for §402. The study reports that traditional abatements resulted in acute increases in the lead-contaminated house dust and the blood lead of nearly half of the occupant children. The modified abatement practices used in the study produced only modest short term improvements and were generally considered inadequate to reduce exposure. Immediately following traditional abatement, lead-contaminated house dust levels typically were 10 to 100-fold higher than pre-abatement conditions. Modified abatement also raised dust levels, but generally only half as much. By six months following the abatements, it was clear that neither form of abatement resulted in long-term reductions of blood lead or house dust lead levels, leaving the occupant children at continued risk of excessive exposure to lead and permanent adverse neurobehavioral effects. Even after final clean up, most window sills and floor surfaces remained greater than the target range of 1.5 mg lead/m^2.

The average increase in measured blood lead concentrations within one month after abatement was 6.84 µg/dL for children residing in homes where traditional abatement practices were used (from 36.88 µg/dL to 43.71 µg/dL) and 1.04 µg/dL for those living in homes where modified abatement practices were used (from 34.39 µg/dL to 35.43 µg/dL). Overall, 48 percent of children living in dwellings abated with traditional measures had blood lead increases, and nine children actually had to be hospitalized for the first time for chelation therapy with concentrations exceeding 48.90 µg/dL. Children with reported exposure to the home during abatement had significantly higher post-abatement blood lead than those without such exposure. By six months post-abatement, all of the children that had not yet been treated for excessive blood lead continued to have elevated blood lead concentrations; although, these concentrations were not significantly greater than those before the abatement. By this point five additional children experienced blood lead concentrations greater than 48.90 µg/dL and were hospitalized for chelation therapy.

Amitai et al. (1987) describe four cases where improperly performed abatements can even cause acute lead toxicity. Routine screening identified four children (from different families) between nine months and 3 years old with elevated blood lead levels that warranted abatement. Prior to the commencement of abatement activities, the children's blood lead levels were in a range of 30 to 41 µg/dL. During the course of the abatements, three of the children stayed in the residences at night, and the other child had ample access to his apartment. The abatements used conventional methods, including burning, scraping and sanding of the existing lead paint. One to four weeks after the abatements were completed, these four children were admitted to a hospital with symptoms of extreme lead toxicity. Their blood lead levels at that time ranged from 90 to 130 µg/dL. All of the children received chelation therapy (two required multiple chelations), and their blood lead levels returned to approximately their pre-abatement levels. Amitai et al. also provide direct evidence that improper abatements can result in lead exposure to adult residents as well as to children. The uncle of one of the children, who lived in the same apartment and returned every night during the abatement, had a blood lead level of 70 µg/dL in the middle of the protracted (one month) abatement.

Amitai et al. (1991) provide evidence that while abatements can result in an immediate (and perhaps temporary) rise in the blood lead levels of residents, better procedures can result in both short-term decreases in blood lead levels, and larger long-term decreases. Their study examined 114 children between the ages of 11 months and 6 years old. All the children lived in Massachusetts, and were identified through routine screenings performed by their primary health care providers. All the children had pre-abatement blood levels greater than 25 µg/dL (the mean was 36.4 µg/dL), and lived in a housing unit with lead paint (lead in paint loads > 1.2 mg/cm^2) below the four foot level that was loose or peeling. Trained inspectors (trained and certified according to the Massachusetts program) identified the lead paint in the residences that needed to be abated, and inspected the work sites during the abatements. They also provided information to the residents on the importance of removing children during abatement, and a thorough clean-up using trisodium phosphate cleaning solution (although some residents did not follow either recommendation). During the abatement, the mean blood levels rose to 42.1 µg/dL. However, 49 days after the abatements, the mean blood levels had dropped to 33.5 µg/dL, a statistically significant improvement from the pre-abatement levels. A long-term follow-up examination was also conducted for the subset of children (59 total) that never received chelation therapy. This subset had a pre-abatement mean blood lead level of 35.7 µg/dL, a mid-abatement level of 35.5 µg/dL, and a post-abatement level of 31 µg/dL. However, the follow-up exam conducted 250 days after abatement found a mean blood level of 25.5 µg/dL, a statistically significant further decrease from the post-abatement levels.

Partial abatements that remove lead paint only up to the four foot level may not be fully effective at preventing future lead exposures from paint. Chisolm (1986) reports several instances of children with blood lead levels over 25 µg/dL who live in housing that was deliberately abated (in response to lead poisoning cases) ten or twenty years previously. The abatements modelled in this analysis meet the standards given in section 745 of 40 CFR and are described in section 3.4.1 of this document.

The §402 training and standards regulations will potentially reduce residents' exposure in three ways. First, to avoid exposure during the period with the highest potential exposure, the regulations recommend that residents vacate the premises during abatement activity. Also, they should not be present in work areas or adjacent areas during abatement until the post-abatement dust and soil clearance standards are met. (They may remain in other areas in the building as long as the lead dust levels constantly remain below the lead dust clearance levels.) Second, to prevent residents from being exposed to dust and debris created during abatement, the regulation specifies post-abatement clean-up standards and testing. Without the proper cleanup assured by meeting the dust clearance standards, the residents' exposure to lead could actually increase due to abatement. The level of clean-up required to meet the dust clearance standards will remove most lead-contaminated dust, including dust present before the abatement began. Finally, current and future residents' potential long-run exposure will be reduced because the inspection, risk assessment and abatement will be conducted by trained and certified labor following established standard procedures. Thorough inspection and preparation of a written "Pre-abatement Plan" will avoid omitting unrecognized surfaces of the house that contain lead paint. All necessary and effective permanent abatements will be identified, and certified inspectors will prepare the abatement plans and perform post-abatement inspection, assuring that the standards have been met. The extent that exposure reduction will occur will depend on the degree of change in actual practices that result from the training and work practice standards.

Workers While reducing occupational exposure is not the primary purpose of §§402, the training requirements and work practice standards may provide additional reductions in occupational exposure of workers performing housing and daycare abatements. The Occupational Safety and Health Administration (OSHA) has primary responsibility for occupational exposure, and recently issued an interim final regulation for the construction industry sufficient to achieve a Personal Exposure Limit (PEL) air concentration of 50 $\mu g/m^3$. The §402 training and standards requirements may help workers comply with the OSHA PEL. The EPA training requirements, which included both classroom and hands-on portions, will not only make workers better informed about how to perform abatements in a manner that reduces their personal risk, but it may also make the workers more aware of lead's risks to their health. This awareness may inspire workers and their supervisors to rigorously meet (or exceed) the work practice standards. In addition, EPA is restricting the use of certain work practices that are not prohibited by the OSHA regulations. In particular, restricting the use of dry scraping in target housing and child-occupied facilities may reduce the exposure to workers.

The §402 training requirements and standards also apply to inspectors and risk assessors. Their on-site work sometimes occurs in a work environment with potentially high levels of lead exposure. Further, their work entails disturbing existing dust levels and collecting paint chips, deliberately increasing their immediate contact with materials containing lead. The combination of training in proper inspection and risk assessment, as well as techniques and procedures to minimize personal exposure, may reduce the inspector's and risk assessor's exposure.

Numerous accounts of lead poisoning among individuals working as full time abatement workers have been reported, especially before educational campaigns warning of the effects of lead exposure became widespread. In one extreme instance a 35-year old man, who had been working for six months removing lead paint from interior walls with sanding machines, burning equipment, and chemical solvents, was admitted to the hospital after generalized convulsions. He admitted that he did not wash his hands before eating and only sporadically wore gloves or a mask. His blood lead was found to be 600 μg/100 g of whole blood (Feldman 1978). The use of high dust generating methods of lead abatement simply exacerbates the problem of exposure to lead bearing dust. High dust concentrations increase the inhalation and ingestion of lead by the abatement worker, in addition to increasing the lead content of household dust. The Massachusetts Department of Labor and Industries, Division of Occupational Hygiene found that the air at the job site of one worker sanding an outside post that contained 2.5 mg lead/cm^2 had an dust concentration of 0.51 mg lead/m^3 after just 22 minutes. Sanding on inside window sills with a lead content of 0.8 to 0.9 mg/cm^2 resulted in air concentrations as high as 0.55 mg lead/m^3 in only 5 minutes (Feldman 1978). Further, lead in paint and dust particles may also be transported away from the job site on a workers clothing and contaminate a worker's family members. Researchers have found that the mean blood lead levels in abatement workers' children were significantly higher than those in control children and were correlated closely with the lead content of household dust in the abatement worker's homes (Feldman 1978).

Many homeowners that choose to abate their own homes are particularly susceptible to lead poisoning. Heat guns are commonly used to soften the old paint and facilitate its removal. The air temperatures from the heat guns often reach 500°C at which point the lead-based paint readily generates lead oxide fumes. The inhalation of these fumes can lead to lead intoxication. Such sources of nonoccupational lead exposure are often overlooked, as the resulting symptoms are nonspecific. Fishbein et al. (1981) reports on two such cases. In the first case, a 42-year old white male editor sought medical attention because of unusual fatigue, malaise, diffuse joint and muscle pain, and abdominal discomfort. He had also noted a weight loss of 5 kg during the last 2 months, despite a normal appetite. His past health had been good and his physical exam normal, however his blood lead was 98 μg/dl. The editor was treated with chelation therapy to reduce his blood lead. The second case involved a 35-year old white male computer operator who had been working part time, about 20-30 hours per week, removing lead-based paint with a heat gun. He complained of dizziness, headache, fatigue, diffuse muscle pains, cough and sputum production, a 3 kg weight loss and a metallic taste in his mouth. His past medical history and physical exam were normal, however his blood lead was measured at 68 μg/dl.

The Occupational Safety and Health Administration (OSHA) examined the exposure of construction workers during abatements to lead, and concluded that elevated blood lead levels are not limited to cases of extremely high blood lead levels. An OSHA analysis prepared in support of the regulation setting Personal Exposure Limit (PEL) for airborne lead from abatement and deleading activities regulation (OSHA, 1993) provides an analysis of the effect on mean blood levels of construction workers engaging in lead paint abatements and related activities.

The OSHA analysis used a detailed exposure model and information on current industry practices to estimate the mean blood levels in construction workers before and after enforcement of the PEL. The OSHA regulatory baseline estimated that before the PEL was enforced, many workers engaged in private housing abatements already follow the procedures recommended by the Department of Housing and Urban Development (HUD) for limiting lead exposure (the HUD "good practice" guidance is not as rigorous as the level of protection that will be provided by the training and work practice standards required by §402). OSHA estimated that the mean blood levels for these workers was 7.2 µg/dL, and that no workers would have blood lead levels exceeding 15 µg/dL due to occupational exposure.

Workers who do not follow the HUD good practice guidance have a significantly higher estimated blood lead levels. OSHA estimated that the mean blood lead levels for this group of workers is 33.8 µg/dL. This very high mean level is not the result of a very few extreme cases; 76 percent of the workers are predicted to have blood lead levels between 15 and 50 µg/dL, and only 3 percent of the total workers not following the HUD guidance experiencing blood lead levels over 50 µg/dL.

Other Potentially Exposed People and Ecosystems In addition to the people directly associated with the abatement activities, people in the vicinity of such activities could also be exposed to elevated levels of lead. These potential exposures will be mitigated by the work practice standards and required clean-up activities. The potential exposure to other people is probably greatest for large scale, outdoor deleading activities, such as bridge and super structure repainting (which are not covered by the current rule). The large quantities of old lead paint that are removed in preparation for repainting can potentially expose people living near, or passing by, the worksite to large quantities of dust and paint chips. In addition to people, ecological damage to plants and animals is possible from soil, surface and ground water toxic contamination from the removed lead paint. Large quantities of removed lead paint can be concentrated in small areas at a worksite. The §402 training and work practice standards will reduce this type of potential exposure. Proper cleanup and disposal of waste materials from all abatements will also reduce exposure from improper disposal.

3.2 Identification of the Market Failure that Requires Regulatory Intervention

Exposure to lead-based paint in target housing and child-occupied facilities is a classic case of an economic externality. Economists define an externality as a divergence of private and social costs, such that an action taken by one economic actor results in uncompensated costs to others. The presence of lead paint poses an exposure risk to the building occupants that is often internalized in the costs to the building's occupants. The decision to originally apply the lead-based paint was made without considering the effects on the then-current or subsequent residents. If the decision on whether to abate the residential paint is made without considering the health effects on the future occupants, the externality will result in an insufficient and inefficient level of abatement activities being undertaken.

Lead paint also involves a second fundamental type of market failure: inadequate information. In many cases the lead exposure takes place without public knowledge. The direct risk of lead paint is not directly observable by an untrained person, and the risk increases from long-term exposure to low levels of lead contamination. Moreover, the nature of the lead paint hazard is such that improper abatement actions may actually increase, rather than decrease, the risk of exposure. The untrained consumer has insufficient information to judge the need for an abatement, or the adequacy of the lead paint removal activities when they occur. The lack of information prevents the potentially affected people from examining the risk they face, and making their own decisions about the appropriate response to the risks of lead paint.

An owner-occupant of a housing unit may have inadequate information to fully evaluate the costs and benefits of abating existing lead-based paint, and thus makes a privately inefficient decision. Inefficient decisions include both performing abatements when one is not needed, as well as failing to abate when the value of the private risk reductions exceeds the costs. However, an owner of rental property faces a combination of an externality and inadequate information. Even if the owner understands the risks of lead-based paint, the expected return on the incremental investment (i.e., the abatement costs) depends on the market demand for lead-free housing. If the market clearing price is determined by renters who are unwilling to pay more for lead-free housing, the owner will be unable to charge a premium for abated property. In such a case, the owner would face all of the costs, but not receive either the health benefits or any compensation. Thus insufficient information on one side of the market can create a wedge between private costs and social costs, and lead to an inefficient outcome.

These external diseconomies illustrate the need for government regulation to require that people engaged in lead paint removal activities be thoroughly trained, and that all lead paint removal activity be conducted by properly trained labor using techniques that meet minimum work practice standards. Regulations that result in building owners and operators internalizing the costs of this health risk act to reduce the difference between private and social costs. In many cases the decision to abate will still be a voluntary, private decision, but the affected populations will be better informed about the risks and appropriate abatement procedures.

3.3 Potential Need for Federal Regulation

In the Residential Lead-Based Paint Hazard Reduction Act of 1992, the United States Congress identified the elimination of lead-based paint hazards as a national goal to be pursued as expeditiously as possible. Congress found that the Federal Government must take a leadership role in building the required infrastructure, including an informed public, State and local delivery systems, certified inspectors, contractors, and laboratories, trained workers (§1002(8)). Sections 402 and 404 provide a key foundation towards this national goal by creating the training and certification program, and work practice standards, for lead-based paint activities. The minimum federal standards established in §402 may be implemented by State programs, which may be more restrictive than the federal standards.

The federal standards for training and certification, as well as for the work practice standards, will protect the rights of all of the nation's citizens by establishing the minimum acceptable level of protection from lead-based paint hazards. However, §404 encourages the individual States to adapt the federal standards to the specific conditions that exist in the States by utilizing existing State and local programs, and by opting to impose requirements which are more stringent than the minimum federal standards. Thus the States may respond to regional diversity and local political choice by building upon the minimum foundation established by §§402 and 404.

In addition to helping meet the national goal of eliminating lead-paint hazard, Federal standards are also likely to be more efficient than standards adopted independently by each individual state. Rather than forcing each State to develop their own training and certification programs, §404 (d) requires EPA to develop a Model State Program. This provides States the opportunity to adopt the Model Program without bearing the cost of developing their own program independently. Section 404(d) also encourages reciprocity among the States, which will diminish any barriers to interstate commerce that would likely be created by independent State development of training programs and standards.

3.4 Regulatory Options Analyzed

In response to Title IV of the Toxic Substances Control Act (TSCA), EPA is regulating lead-based paint activities. The Act defines the term lead-based paint activities as inspection, lead hazard screen, risk assessment, and abatement. The rule addresses three major areas of concern in lead paint activities:

- Work practice standards
- Training - accreditation of programs and certification of individuals and firms
- State lead program requirements

The intent of this rule is to ensure that individuals engaged in lead-based paint activities are properly trained; that training programs are accredited; and that contractors engaged in such activities are certified. This rule also establishes standards for performing lead-based paint activities and requires that all lead-based paint activities be performed by certified individuals. As such, this rule fulfills the mandate of §§402(a) and (b) of Title IV of TSCA. As part of this rule EPA has, in accordance with §404 of Title IV of TSCA, developed a Model State Program. This program may be adopted by any state which seeks to administer and enforce a state program under Title IV of TSCA. This Final Rule incorporates several changes based on comments received by EPA in response to publication of the proposed rule. In the September 2, 1994 issue of the *Federal Register*, EPA published the Proposed Rule: Lead; Requirements for Lead-based Paint Activities. The proposed regulation was developed by EPA's Section 402/404 Lead-Based Paint activities Workgroup, in close consultation with representatives of the regulated community and other interested parties. When the Proposed Rule was published, EPA actively sought comments and suggestions for improvement. In response, the Agency received numerous comments from the regulated community, public interest and environmental groups, and other interested and/or affected parties. After carefully reviewing these comments and analyzing their suggestions, EPA made several changes to refine the regulation. The changes made by EPA are of two types. One set of changes involve revisions to definitions and affect all parts of the regulation. The second set involves changes to specific requirements. The first set contains two changes:

- A new category of buildings was created; child-occupied facilities were separated from other public buildings.

- The §403 Guidance, published in July 1994, was used to define when abatements might be considered appropriate.

In addition to these two changes, the Agency made a set of smaller changes intended to streamline the requirements in such a way as to maintain the benefits of the Proposed Rule while reducing the burden on the regulated communities. Under the Final Rule, training has been shortened for two professional groups (project designer and worker). In terms of work practice standards, the Final Rule includes two changes: it restricts the use of certain abatement techniques that were not restricted under the Proposed Rule, and it reduces the number of soil and dust samples to be analyzed as part of the post-abatement clearance. In addition, the rule no longer specifies the amount of soil to be removed in a soil abatement.

Additional changes made as EPA moved from the Proposed to the Final Rule include changing the necessary qualifications for instructors in the training courses and the course content, and clarifying that abatements can occur at the component level and that training hours always included time for breaks and lunch.

The following sections summarize major aspects of the rule as they apply to target housing and child-occupied facilities. For more detail, consult the Federal Register Notice.

3.4.1 Standards for Conducting Lead-Based Paint Activities

As mandated by Title IV, standards of performance are being set for target housing and child-occupied facilities. Within each structure or building type, various lead paint activities are defined and regulated. These standards are based on considerations of reliability, effectiveness, and safety.

Inspection EPA has established standards that must be followed when conducting inspections for lead-based paint in target housing. These standards are also applicable to the identification of lead-based paint in child-occupied facilities. The objective of an inspection is to determine, and then report, the existence of lead-based paint through a surface by surface investigation.

The first step in an inspection is the development of a sampling and analysis plan, followed by a determination of what units in a building shall be inspected. EPA has defined a unit as a room or connected group of rooms used or intended to be used by a single tenant or owner. EPA has also set guidelines for inspecting scattered-site units and multi-family dwellings.

Methodologies and technologies for inspections may change over time; therefore, this rule lists few absolute requirements as to what methods to use. However, inspections must be conducted with technologies which, by design, give discrete values for lead concentrations. Currently, there are at least two methods that meet this criteria, X-Ray Fluorescence (XRF) analysis, and laboratory analysis using an atomic absorption spectrometer (AAS).

While the methodologies for conducting this inspection may change over time, the inspection standards require that the inspector prepare a written inspection report that details the findings of the inspection and the methods used during the inspection. The inspection report is subject to disclosure requirements of the regulation currently being developed under section 1018 of Title X.

Lead Hazard Screen The objective of a lead hazard screen is to determine the absence of lead-based paint hazards. It is characterized by the use of highly sensitive evaluation criteria and limited sampling. The Agency recommends that the lead hazard screen be used primarily in well-maintained housing units built after 1960. A lead hazard screen consists of: 1) a visual inspection, 2) the sampling of components with deteriorated paint, 3) the collection of a minimum of two composite dust samples, and 4) the preparation of a report on the results of the screen.

Risk Assessment The objective of a risk assessment is to determine and then report the existence, nature, severity and location of lead-based paint hazards in residential dwellings through an on-site investigation. Like the inspection, the risk assessment is "report driven" — meaning that the risk assessor is required to report where samples are taken and the results of the investigation. The first step of a risk assessment is to survey the unit to evaluate its overall condition and take paint and dust samples where appropriate. A risk assessment also includes analysis of the age and history of the building and occupancy by children under the age of six. As a final step, lead hazard control strategies are identified and recommendations made.

Like the inspection report, the lead hazard screen and/or risk assessment report is subject to disclosure requirements of the regulations currently being developed under Section 1018 of Title X.

Abatement This rule defines an abatement as any measure or set of measures designed to eliminate lead-based paint hazards in accordance with standards established by the Administrator under Title IV of TSCA. Such measures are to be permanent or relatively permanent and include, but are not limited to:

> (A) the removal of lead-based paint and lead-contaminated dust, the containment or encapsulation of lead-based paint, the replacement of lead-painted surfaces or fixtures, and the removal or covering of lead-contaminated soil; and
>
> (B) all preparation, cleanup, disposal, and post-abatement clearance testing activities associated with such measures.

The rule further states that an abatement includes, but is not limited to, the following circumstances:

> (A) projects for which there is a written contract stating that an individual or firm will be conducting activities in or to a dwelling unit that will permanently eliminate lead-based paint hazards; or
>
> (B) projects involving the permanent elimination of lead-based paint or lead contaminated soil and conducted by firms or individuals certified in accordance with this section 745.226 or this regulation; or
>
> (C) projects involving the permanent elimination of lead-based paint or lead contaminated soil and conducted by firms or individuals who, through their company name, promotional literature, or otherwise advertise or hold themselves out to be lead abatement professionals; or
>
> (D) projects where the abatement is conducted in response to state or local abatement orders.

As defined in this rule, an abatement must be conducted by an individual certified by the appropriate approving authority as a worker or supervisor. Before abatement work is started, a project design must be completed and, for multi-family residential work, a pre-abatement notification must be submitted to the approving authority. The project design must address occupant protection issues. The Agency has determined that the recently promulgated interim final Occupational Safety and Health Administration (OSHA) standard for lead will adequately protect all workers engaged in lead-based paint abatement. This Final Rule is intended to complement the OSHA rule.

The work practices listed below are restricted during an abatement in target housing or child-occupied facilities due to the risk of lead contamination posed by these practices to workers and/or building residents:

- open-flame burning or torching is prohibited;
- machine sanding or grinding is permitted only with HEPA exhaust control;
- abrasive blasting or sandblasting is permitted only with HEPA exhaust controls;
- operating a heat gun is permitted only at a temperature below 1100 degrees Fahrenheit; and
- dry scraping permitted only with heat guns or around electrical outlets when treating defective paint spots or on surfaces less than 3 square feet.

3.4.2 Training Programs - Accreditation

Section 402(a)(1) of Title IV of TSCA requires EPA to "promulgate final regulations governing lead-based paint activities to ensure...that training programs are accredited..." Section 402(a)(2) states that these regulations must contain specific requirements for accreditation of lead-based paint activities training programs. These requirements have been established to ensure that all accredited training programs are offering similar high quality training courses to ensure that individuals are properly trained. The rule also establishes procedures for de-accrediting training programs.

The rule includes a list of topics that must be covered in each of the courses, as well as skill areas where hands-on training should occur. There are minimum curricula requirements for inspectors, risk assessors, project designers, supervisors, and workers in target housing and child-occupied facilities.

Any course seeking accreditation must demonstrate that it meets the minimum requirement for the:

- accreditation of training providers,
- training curriculum,
- classroom training,
- hands-on training,
- trainee competency and proficiency, and
- training program quality control.

To ensure that training programs continue to offer high quality training, training programs must be re-accredited every four years.

Accreditation of Refresher Training Programs Training programs that have already received accreditation for a particular discipline, or are currently seeking such accreditation, may seek accreditation to offer refresher training for that discipline. The refresher course would serve to update an individual's knowledge and skills so they can effectively and safely continue to practice in the field.

Course Test and Hands-On Skills Assessment Training programs are required to administer a test to trainees upon completion of the course. The test is an evaluation of the overall effectiveness of the training. The test must cover the topics covered during the course. Training programs must make provisions for workers with low literacy to take the course test. Passage of the test (70 percent or better) by the trainee demonstrates that they have successfully completed the training course and are considered properly trained for this discipline. In addition, the training program must conduct a hands-on skills assessment in which the trainee must demonstrate satisfactory performance of specified work practices.

Training Programs Recordkeeping Requirements Training programs must maintain records on the qualifications of their staff, curriculum, tests, hands-on assessments conducted, and student records. The recordkeeping requirements have been established to ensure that the approving authority can obtain the information necessary to audit programs and enforce the provisions of this rule. The training programs must retain these records for a minimum of three years and six months.

3.4.3 Certification of Individuals and Firms

Lead inspection and abatement personnel must be certified. To ensure that individuals are adequately trained and certified, the Agency has developed two distinct training and certification programs. One of the programs has been designed for individuals engaged in lead-based paint activities as workers and project designers. The other program has been designed for individuals engaged in lead-based paint activities as inspectors, risk assessors, and supervisors.

Inspector, Risk Assessor or Supervisor Certification Individuals wishing to become certified as an inspector, a risk assessor or supervisor must successfully complete the appropriate training course offered by an accredited training program and secure a course completion certificate, meet the experience and/or education requirements, and pass the certification test offered by the approving authority. The test will serve to ensure that all individuals who are certified under this program have the necessary level of knowledge and understanding in their particular discipline.

In order to take the certification test, an individual must show the course completion certificate and documentation of education and/or experience prerequisites. After passing the certification test and meeting the education and/or experience prerequisites, an individual will be issued a certificate by the approving authority. This certification will be valid for 3 years.

The test itself will not be promulgated with this regulation, but will be developed separately under the auspices of the EPA. The goal of the system of having certification tests is to give each state the flexibility they desire in adopting this certification program, while at the same time ensuring a national level of competence in the lead-based paint activities workforce.

Worker and Project Designer Certification Individuals wishing to become certified as a worker or a project designer must successfully complete a training course offered by an accredited training program. Following course completion, workers and project designers will be certified on an interim basis. The trainees will notify the approving authority that they have completed the appropriate training course, and then the approving authority will issue a certification to each worker or planner/designer. This certification will be valid for three years. An individual must be re-certified by the approving authority before the certification expires.

Grandfathering Anyone who has been trained by an EPA recognized state program before the effective date of this rule may be eligible for certification by the approving authority. Inspectors, risk assessors, and supervisors must show proof of training for the discipline for which certification is being sought and proof that they meet the education and/or experience requirements. These individuals must also successfully complete a refresher training course, and pass a certification test for that discipline. Workers and project designers seeking grandfathering must provide proof of training and successfully complete a refresher training course. Individuals have until 6 months after the effective date of this rule to apply for certification under the grandfathering procedures.

Recertification Refresher training will be required every three years. Individuals must successfully complete a refresher training course at an accredited training program, pass the refresher course test, and submit proof of completion of this course to the approving authority. EPA has also established guidelines for decertifying individuals.

Certification of Firms The rule states that in order to become certified, a firm must submit a letter to the approving authority certifying that the firm will only employ certified employees to conduct lead-based paint activities and that the firm will follow the work practice standards and recordkeeping requirements of the rule.

3.4.4 Model State Program

In order to fulfill the mandate of Title IV of the Toxic Substances Control Act (TSCA) §404, EPA has developed a draft Model State program for lead-based paint activities training and certification. The Model State Program will serve as a blueprint for states that seek to administer and enforce a state program under Title IV of TSCA.

The Model State Program contains the following elements:

- procedures for EPA authorization of state programs;
- guidance for states in establishing state certification and accreditation programs;
- EPA training, accreditation and certification requirements including minimum requirements for:

    - accreditation of training providers;
    - training curriculum;
    - training hour definition;
    - hands-on training;
    - trainee competency and proficiency; and
    - training program quality control.

Submission of State Application Any state that seeks to administer and enforce the standards, regulations, or other requirements contained in the EPA Training and Certification Program for Lead-Based Paint Activities shall submit an application to the Administrator of the Environmental Protection Agency. Submissions for approval should be submitted by an authorized state representative to the Agency.

EPA Approval Within 180 days of receipt of a state application, the Administrator shall approve or disapprove the application. The Administrator may approve only if, after notice and after opportunity for public hearing, the Administrator finds that:

1) the state program is at least as protective of human health and the environment as the Federal program, and
2) the state program provides adequate enforcement.

Withdrawal of Authorization If a state is not administering and enforcing an authorized program in compliance with the standards, regulations, and other requirements of Title IV of TSCA, the Administrator shall so notify the state and, if corrective action is not completed within a reasonable time, not to exceed 180 days, the Administrator shall withdraw authorization of such program and establish a federal program pursuant to Title IV of TSCA.

Structure of State Accreditation and Certification Program In order to successfully administer and enforce the EPA Training and Certification Program for Lead-Based Paint Activities, a state must develop the appropriate infrastructure. By legislation, a state must establish an agency or agencies, or designate an existing state agency or agencies to implement, administer and enforce the state program.

This agency or agencies must promulgate regulations which:

- Require certification of individuals and firms engaged in lead-based paint activities.

- Establish training requirements for inspectors, risk assessors, project designers, supervisors and workers involved in the performance of lead-based paint activities.

- Establish the accreditation of training programs.

- Establish standards for performing lead-based paint activities, taking into account reliability, effectiveness, and safety.

- Provide for the enforcement of the state certification program and establish suitable sanctions for those who fail to comply with program requirements.

The agency or agencies should have the authority to charge a certification fee to all certified individuals engaged in lead-based paint activities and a fee on all accredited training programs. The fee shall not be imposed on any state, local government, or nonprofit training program.

Finally, EPA encourages each state to establish reciprocal arrangements with other states that have authorized state programs.

3.4.5 Applicability of General Types of Regulatory Options

Having found that lead paint in American housing continues to present a substantial hazard for children, Congress stated in Title IV that:

> the Federal government must take a leadership role in building the infrastructure — including an informed public, state and local delivery systems, certified inspectors, contractors, and laboratories, trained workers, and available financing and insurance — necessary to ensure that the national goal of eliminating lead-based paint hazards in housing can be achieved as expeditiously as possible.

Given the urgency of eliminating lead-based paint hazards, Congress mandated a very abbreviated schedule for developing the regulations. This schedule restricts EPA's ability to formally analyze a wide range of regulatory options. Instead, EPA met with a broad range of interested parties to solicit information while developing the proposed regulation. In addition, the Agency carefully reviewed written comments from dozens of individuals, firms, organizations and states, each providing their own perspective on the issues of training, accreditation, certification, and standards for lead-based paint activities. The rule presented in this report reflects changes made by EPA after careful consideration of the comments on the proposed rule.

In addition to setting training and work practice standards, Title IV relies on expanded information to reduce lead-based paint hazards. As stated by Congress, the provision of additional information plays a central role in this rule. It is the intent of the regulation to provide additional information about the hazards of lead-based paint and the proper procedures for removing or reducing those hazards. This information will be provided to consumers through various disclosure requirements (e.g., §406, analyzed in another report) and to inspectors and lead abatement personnel through training. Certification of lead-based personnel and firms provides information to consumers, enabling them to choose inspectors and lead abatement personnel who are capable of providing safe, effective and reliable services. Accreditation provides information to those seeking training, enabling them to obtain the training necessary to protect themselves, the structure's inhabitants, and others in the vicinity of the work while eliminating the lead paint hazard.

This increase in information is particularly important since the presence of lead cannot be detected visually. While the likelihood that a house or structure has lead paint increases under certain circumstances, such as the age of the structure, the presence of lead can be determined only through scientific tests. Additional information increases the efficiency of the delivery system by increasing the number of abatement activities with a positive net benefit and decreasing the number of activities where the net benefit is negative. Abatements can be costly and proper inspections and risk assessments prevent spending money where no benefit will be realized because no lead paint hazard is present.

The rule also includes work practice standards and restrictions on certain procedures to protect people and the environment from unnecessary exposure. Since this rule affects an activity or service, not a product, work practice standards are particularly appropriate. The success of these work practice standards is closely tied to the success of the training programs, which is in turn ensured by the certification and accreditation requirements described above.

While the regulations analyzed in this report do not incorporate any direct economic incentives, they do benefit from economic incentives indirectly. The increase in available information and the requirements to use trained and certified workers will increase the value of lead abated housing units, or inspected housing units found to be free of lead, providing a monetary return on the cost of inspections and abatements. The requirements will also allow the liability system to more efficiently shift the costs onto those responsible for the remaining hazards.

In summary, the rule relies on two regulatory approaches: standards and increased information. Both are specified in the Act. In developing the rule, however, various options were not formally evaluated. Instead, the rule is based on the experience of states, evaluations performed for other regulations, and expert opinions representing both the regulated community and the potential beneficiaries.

4. OVERVIEW OF THE ANALYTIC MODEL

The appropriate analytical approach for any regulatory impact analysis is a careful consideration of all the effects of a proposed regulation using the "with-and-without" principle. The with-and-without principle refers to comparing the state of the world that is expected to occur if a regulatory option is enacted (the with outcome) with the state of the world without the regulation (also called the regulatory baseline). Thus, the central issue in an analysis of §§402(a) and 404 of the Toxic Substances Control Act (TSCA) is to identify, quantify and value the private and social benefits and costs of requiring that all lead-based paint abatement activities be performed by certified personnel trained by an accredited training program, and that all lead-based paint activities meet certain minimum work practice standards.

While there are no provisions in §§402(a) and 404 that are designed to change the quantity of abatements, other portions of the Lead-Based Paint Hazard Reduction Act of 1992, also known as Title X of the Housing and Community Development Act of 1992 (HCDA), are intended to increase the amount of housing abatement that will occur in the future. For example, sections may increase the number of abatements that would occur by making the public more aware of the presence and dangers of lead-based paint (such as TSCA §406 and HCDA §1018). In turn, this increase in abatement activities could, in the absence of §402(a), have the unintentional effect of increasing the number of people at risk due to poorly performed abatements.[1] Therefore, the regulatory baseline for the §402(a) analysis includes the current level of lead-based paint activities (i.e., the current number of inspections and abatements, etc.) plus the additional number of lead-based paint activities resulting from other portions of Title X.

The §402(a) standards and training will primarily improve the "quality" of lead-based paint activities by lowering the residual risks during and after the abatements occur. As such, the §§402(a) and 404 benefit analysis can not "take credit" for benefits from performing the baseline number of lead-based paint activities at the baseline "quality."[2] It would be appropriate, therefore, to include only the incremental improvements in benefits resulting from following the training and standards requirements. Likewise, the §§402(a) and 404 cost analysis cannot be charged with the baseline costs of any of the abatements, but

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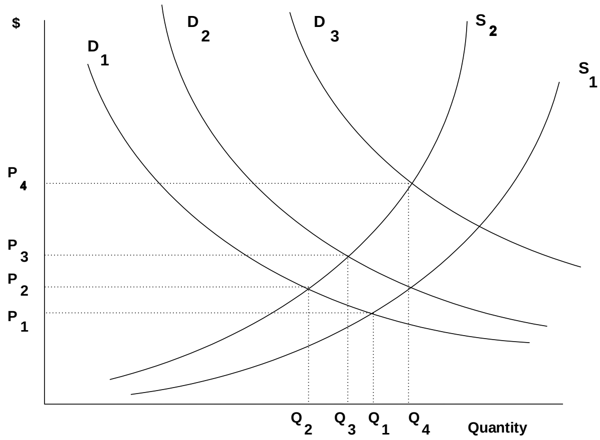
[1]Poorly performed abatements can result in immediate increases in lead exposure due to inadequate protection of residents and others in the area, and to inadequate clean-up of lead dust and debris after the abatement. Poorly performed abatements, and inspections/lead hazard screens/risk assessments, can result in long-term hazards due to failure to identify and/or remove lead hazards. As a result, children might be exposed even though their parents were told the units were lead-free.

[2]The identification of baseline quality is further complicated by the fact that the baseline is not the industry practice "quality" currently used in abatements. The U.S. Occupational Safety and Health Administration (OSHA) recently promulgated worker safety standards for the construction industry that will (since the OSHA standards are tighter than recent general practices) increase the "quality" of abatement activities. The benefits and the costs from implementing the OSHA standards are included in the regulatory baseline for §§402(a) and 404.

is charged with the incremental costs on all abatements due to the increased training and certification requirements and the new work practice standards.

To the extent that implementing the §§402(a) and 404 training and standards requirements results in a net increase in the unit cost of lead-based paint activities, the total quantity of lead-based paint activity services demanded will decrease[3]. This is a normal consequence of the interaction of supply and demand; an upward shift in the supply curve (due to the increased unit cost of abatement) will result in a smaller quantity purchased at a higher cost.



The effect of the supply shift is shown in the accompanying figure as the change from the original price and quantity combination (P_1, Q_1) to the resulting price and quantity combination(P_2, Q_2). In addition to the movement along the demand curve, a second effect may occur that further increases price, by increasing the quantity consumed. It is possible that the demand will shift due to the increased information about the dangers of lead-based paint. Additionally, if people perceive that abatements performed by trained and certified contractors are a better quality service than currently available, the demand for the improved abatements may increase. These shifts in the demand curve reflect both the increased perception of benefits by the current owner and the capitalized value of increased demand by future owners. For example, the current owner may receive increased benefits due to protecting his own children, and future owners also received greater benefits from protecting their children. This shift in the demand curve (to D_2 or D_3) will increase the market clearing quantity demanded above the (Q_2, P_2) level, and also result in a higher price. In addition to the benefits received directly by the owners of properties, society as a whole receives benefits from knowing that there is greater protection from lead exposure, particularly for children. The final demand could be less than (shown as $Q_3 < Q_1$) or more than ($Q_4 > Q_1$) the original quantity demanded, but the final price will unambiguously be greater than the original price (P_1) except for the situation discussed in footnote 3 below. If the final quantity demanded is less than the original quantity, the resulting loss of benefits from any foregone lead-based paint activities is an additional cost of §§402(a) and 404 (i.e., a negative benefit). Thus the post-§§402(a) and 404 quantity of activities could be less than

[3]It is possible, but not likely, that the standards and training requirements will actually result in lower per-unit abatement costs. For example, the training and standards may improve the efficiency of labor, workers may miss fewer days of work because of exposure related effects, or labor turnover in the lead paint activity industries may decrease due to lower actual and perceived risks.

the baseline quantity. The benefits of §§402(a) and 404 are limited to the benefits from the §§402(a) and 404 "quality" improvement for the post-§§402(a) and 404 quantity, minus the loss of all benefits of the baseline "quality" for the change in quantity if there is a price increase for lead-based paint activities.

As described in the following sections, data limitations prohibited a full implementation of this conceptual model; it was not possible to fully model the shifts in the demand and supply curves. First, there are no data on the number of lead-based paint activities in states without regulations on which to base a baseline national estimate of numbers of events. Second, there are no estimates of the price or quality elasticities of demand on which to estimate the shifts in, or movements along, the demand curves. In the estimations presented in this report, these limitations were partially offset by using data gathered in Massachusetts, which for several years has had a set of regulations similar to those analyzed in this RIA. The regulations have been in effect long enough for the market to have reached an equilibrium. In other words, the level of activity in Massachusetts reflects the joint effects of increased costs and increased quality in a market environment with generally high levels of information about the hazards of lead-based paint.

Any analysis of the impacts of a regulation should include an examination of potential negative impacts, even those which are unintended. In addition to their impact on the level of lead-based paint activities, the opposing factors of increased cost and increased quality may affect the supply of housing, in particular, certain segments of the housing supply. The baseline demand for housing will change in response to the educational activities undertaken under other sections of TSCA Title IV. As the hazards associated with lead-based paint become more widely known and appreciated, the value of lead-free housing units will rise and the value of housing units containing lead will decline. Even among lead-free units, there may be differential impacts: housing built after the banning of lead-containing paint in 1978 can be assumed to be lead-free without testing; housing built before the ban will need to be tested, at some cost. If the lead-based paint has been abated, there may be concern that the hazard has not been completely and permanently eliminated, reducing the value somewhat. These shifts in the value of housing units may be accentuated by increased liability concerns.

To some extent, these baseline shifts in relative value of different types of housing units are exacerbated by any rules that increase the costs of lead-based paint activities, further increasing the value of lead-free housing and reducing the value of housing known or thought to have lead-based paint. In extreme cases, these shifts in value might result in the abandonment of borderline housing units, housing units whose baseline value is so low that the rule might reduce the value to zero or below. As a result, the housing abandonment rate may increase, imposing additional costs on society. The important question for this analysis is how much the abandonment rate would increase. A discussion of the rule's potential impact on abandonment is presented in Appendix 4.A. Based on current economic literature, discussions with experts in the field and available data, the analysis concludes that this rule will not increase abandonment rates over the new baseline rates to any measurable degree.

4.1 Major Steps in the Analysis

In its simplest terms, the methodology consists of estimating the 1) incremental per unit cost and per unit benefits resulting from the regulation, and 2) the number of events or persons to which the unit cost and benefits apply. Multiplying the unit cost by the number of units yields the total incremental costs for that category of the regulation, likewise with benefits.

Per unit incremental costs are estimated for the training and certification requirements, for the work practice standards, and for state-level administration and enforcement activities. Training costs consist of tuition costs to cover the cost of providing training, lost productivity measured by wage rates and hours spent in training, and out-of-pocket costs such as transportation. Training costs are calculated separately for initial and refresher training for each discipline. Calculating the incremental costs due to work practice standards requires comparing the required standards to current common practices to identify the changes that would need to occur to bring common practice into compliance with the work practice standards specified in the rule. The costs associated with these changes are estimated in terms of the additional time they would require and the costs of the additional laboratory tests required. State costs are estimated based on program cost data provided by five states. The development of unit incremental costs are presented in detail in Chapter 5 of this report.

The number of lead-based paint events, and the per unit benefits of each event, are dependent in part on the definition of paint conditions that pose a hazard. Based on §403 guidance, the analysis presented in this report assumes that lead-based hazards are present when there is lead-based paint (defined as a lead content of 1.0 mg/cm^2 or more) in deteriorated condition.[4] In addition, lead-based paint on friction surfaces (e.g., on window and door frames) or surfaces accessible to children are assumed to constitute a lead hazard regardless of paint condition, as does soil with lead concentrations of 5,000 ppm or greater. While abatement is not the only solution, and in some cases interim controls may be preferable, abatement or a combination of abatement and interim controls will be undertaken in many target housing units and child-occupied facilities containing lead hazards.

The per unit benefits are estimated separately for children and for adults. The amount of benefit derived from an abatement depends on the level of lead in the dust, which in turn depends on the condition of the paint and the amount of lead in the paint and soil. The development of per unit benefits is described in detail in Chapter 6 of this report.

The number of lead-based paint events per year is estimated by applying inspection and abatement rates observed in Massachusetts to the estimated stock of residential units and child occupied facilities with lead-based paint hazards. The number of such units, by paint

[4] "Agency Guidance on Residential Lead-Based Paint, Lead-Contaminated Dust, and Lead-Contaminated Soil," U.S. EPA, July 14, 1994.

condition and presence of lead-based paint or soil containing lead, is estimated based on data collected by the U.S. Department of Housing and Urban Development (HUD). The number of persons to be trained is a function of the number of lead-based paint events (the demand for personnel) and the number of people already trained (existing supply). The estimates of number of events and number of personnel are described in detail later in this chapter.

For this analysis, the number of lead-based paint events and the number of individuals to be trained are measured on an annual basis, in part for convenience since much of the necessary data are recorded on an annual basis. Training providers tend to track enrollments and state programs tend to track abatement projects on an annual basis. Likewise, some states require inspectors and other personnel to obtain an annual license, providing annual data on the supply of trained persons in the state.

Both the costs and the benefits of the rule will accrue to society over many years. Therefore, the costs and benefits of this rule are calculated over an extended length of time, discounted to provide a present value.[5] Since the present value of benefits or costs 50 years in the future are relatively small, cost and benefits that accrue due to events more than 50 years in the future are not included.

4.2 Major Data Sources

The analysis uses four principal sources of data to estimate the number of lead-based paint abatement events and personnel. These data sources include:

- 1980 United States Census of Housing, and special surveys by the U.S. Department of Housing and Urban Development and U.S. Department of Energy,

- *Economic Analysis of OSHA's Interim Final Standard for Lead in Construction*, 1993, (OSHA, 1993),

- Current Massachusetts abatement, licensing and certification data, and

- Industry representatives and Regional Lead Training Centers.

None of the data sources provide information on all of the disciplines or categories of activities; therefore, the analysis draws from a combination of these sources. Massachusetts data are used for estimating residential activities and number of personnel. Massachusetts has the oldest state program requiring lead-paint inspector, worker, supervisor, and contractor training. As such, it was analyzed as an example of a mature lead-based paint

[5]In addition, the benefits from a single abatement will accrue over an extended period of time; children who live in the unit years after the abatement occurred will benefit from its being lead-free. Therefore, the per unit benefits also are calculated as the discounted stream of benefits over a 50-year period after the abatement occurs.

training market. In addition, although there are some important differences, there are also many similarities between §402 and the Massachusetts requirements, making it an appropriate basis for estimating levels of activities. For example, Massachusetts requires that lead-based paint inspectors and contractors obtain licenses and supervisors be certified. To obtain a license, the person must complete the prescribed training. Abatement notices must be filed with Massachusetts for both partial and full abatements (but not interim controls). Lead-based paint is defined as paint with a lead content of 1.2 mg/cm^2, slightly more than the lead level used in this rule. Appendix 4.B provides a summary of the specific requirements of the Massachusetts lead poisoning prevention regulations. Abatement and training data were collected, however, from other states in order to verify that the Massachusetts data was a reasonable reflection of what is occurring in states with newer lead laws. The data provided by EPA's Regional Lead Training Centers (RLTCs) were used to generate national estimates of the number of personnel trained prior to the effective date of this rule. The analysis uses OSHA estimates for sizes of abatement crews and data for parts of the analyses presented in Chapter 9.

In some cases, state data needed to be extrapolated to provide national estimates. The extrapolation to national estimates relies on housing data from the 1980 U.S. Census of Housing (U.S. Department of Commerce, 1983b), and lead-paint data from a study for the U.S. Department of Housing and Urban Development (U.S. Department of Housing and Urban Development, 1990).

4.3 Estimating the Level of Activity

The regulations analyzed in this report apply to target housing and child-occupied facilities. Target housing includes all housing units built before 1978 except housing for the elderly or persons with disabilities (unless a child who is less than 6 years old resides, or is expected to reside, in the unit) and any zero-bedroom unit. Child-occupied facilities (COFs) include schools, preschools, day care facilities, and other buildings or units within a building constructed prior to 1978 where a child 6 years of age or younger spends at least 3 hours a day two days a week.[6]

Both the total costs and the total benefits of this rule are in part a function of the number of lead-based paint events that occur in a year. In addition to affecting the costs and benefits directly, the number of events affect them indirectly, since the number of people to be trained is also a function of the number of events. Therefore, the baseline level of

[6]Title IV also applies to public buildings, commercial buildings, and steel superstructures such as bridges. Public buildings include any building constructed before 1978, except target housing and child-occupied facilities, which are generally open to the public. This includes museums, airport terminals, hospitals, stores, and restaurants, as well as office buildings, corporate headquarters, and government buildings that do not expressly prohibit access to the public. Industrial buildings are included in EPA's definition of commercial buildings. Public and commercial buildings and steel structures will be subject to a separate rule-making.

activity includes both the number of lead-based paint events and the resulting demand for trained personnel.

Since §402(a) does **not require** inspections, lead hazard screens, risk assessments or abatements, an estimate of the costs and benefits of the rule depends on forecasting the level of voluntary activity that will occur. Straightforward economic theory suggests that introducing new elements to the decision process of purchasers will have potential impacts on the affected markets, in this case target housing or child-occupied facilities. TSCA §402(a) introduces elements that are likely to have opposing effects. On the one hand, the provision of a well-trained and certified workforce, and increased awareness of lead-based paint hazards, are likely to increase the demand for lead-based paint activities. On the other hand, the increase in costs is likely to decrease demand for lead-based paint activities, while sparking an interest and demand for other less costly alternatives to abatement such as interim controls. The analysis presented in this report attempts to forecast the net results of these countervailing forces in terms of the level of activities and the resulting demand for training.

The level of activity will be a function of three factors: the prevalence of lead-based paint hazards, the value people place on reducing these hazards relative to the costs of these reductions, and state requirements. The prevalence of lead hazards is important because all other things being equal, states with a larger number of housing units and COFs containing lead-based paint hazards will have higher levels of lead-based paint events and thus a greater demand for trained and certified personnel. The value people place on reducing these hazards is relevant because the number of activities will increase with increased preferences for lead-free housing units and COFs and with greater assurance of effective, high-quality workmanship, and the number will decrease with the increase in costs. Third, the resulting levels of lead-based paint activity, and demand for trained personnel, will not simply reflect market interactions; many states have laws requiring the abatement of lead-based paint hazards in all cases where children are found to have elevated blood-lead.

Based on the §403 guidance, this analysis of §402(a) assumes that lead-based paint hazards are present where lead-based paint (i.e., lead content of 1.0 mg/cm^2 or more) is in deteriorated condition or in good condition on friction surfaces. In addition, soil hazards in target housing or child-occupied settings are defined as lead concentrations in soil equal or exceeding 5,000 ppm. As described in detail in the next section, the number of housing units and COFs with lead-based paint hazards is estimated using the HUD data and the 1980 Census data.

Massachusetts data are used to define the rate of activity in terms of number of inspections and abatements compared to the estimated number of units with lead-based paint hazards. It is anticipated that the disclosure requirements and the information programs resulting from Title IV will focus on residential exposure and thus Massachusetts can serve as a reasonable proxy for activity levels nationwide. For a couple of reasons, activity levels in Massachusetts may be slightly different than the activity levels across the nation under

TSCA §402(a). Massachusetts uses a slightly less stringent definition of lead-based paint (i.e., lead content of 1.2 instead of 1.0 mg/cm^2). However, at these low levels, it is difficult to distinguish among lead content levels. Second, Massachusetts mandates lead-based paint abatements under certain circumstances, such as housing units where a child has elevated blood lead (EBL). State officials estimate that between 10 and 25 percent of abatements in Massachusetts are required by state authorities; the remainder are voluntary. The analysis assumes that many other states will have a mandatory element to their laws.

Counterbalancing these differences are major similarities. The training and work practice requirements are very similar to those of §402, resulting in similar costs. The state has several programs intended to educate people about the hazards associated with lead-based paint, including a notification at sale of property program similar to §406. Massachusetts officials indicated that programs that inform the public about the hazards of lead have resulted in a large number of voluntary abatements. The rate of voluntary demand, which makes up the majority of inspections and abatements in Massachusetts, is expected to be approximately the same as the national demand will be under TSCA §402. In addition, many other states require inspections and abatements, where warranted, for EBL children. These mandated activities will also be subject to §402(a).

4.3.1 Annual Number of Lead-Based Paint Events

Calculating the number of lead-based paint events involves two steps: 1) determining the number of target housing units and child-occupied facilities where lead-based paint hazards exist, and 2) estimating the rate at which these hazardous units are addressed. These estimates are used to predict the number of lead-based paint events that occur in each year that the rule is effective. The analysis distinguishes between two approaches to abatement: permanent and relatively permanent. Permanent abatement refers to the removal of all sources of lead in the unit. This includes the removal of lead-based paint through such techniques as sanding, scraping, and the use of solvents, and the removal of architectural elements that contain lead-based paint such as the replacement of windows, doors and moldings. Relatively permanent abatement refers to techniques that remove the lead hazard, with a design life of at least 20 years. This includes a variety of enclosure techniques such as the installation of dry wall or siding (for exterior hazards) and encapsulation of the lead-based paint. The analysis assumes that in each of the first 20 years the rule is in effect, one-half of the abatements will be permanent and one-half will be enclosures and/or encapsulations.

In year 21, units which undertook one of the relatively permanent abatement approaches in the first year will be reexamined and the enclosure and/or encapsulation repeated. In this way, the housing unit will remain free of lead hazards. Because of the necessity to repeat the lead-hazard identification and abatement, the number of activities will be greater in year 21 than it was in year 20. Due to demolitions that will have occurred during the 20-year period, however, the number of units receiving their second lead-hazard identification and abatement will be smaller than the number involved in the first round.

Those first-year units that still remain in year 41 will receive a third lead-hazard identification and abatement. These repeated activities are referred to as recurrent, to distinguish them from the initial events. The same sequence applies to units abated in years 2, 3, 4, and so forth.

Under TSCA Title IV, states and Indian tribes (including Alaskan Native Villages) are encouraged to gain authorization to administer these programs. The process of authorization will start with the promulgation of the regulation; states and tribes have no more than one-and-one-half years to apply for authorization. EPA has up to 180 days to approve each submission. While states that have existing lead laws and state lead programs in place will most likely be certified early in the first year, other states may not be certified until two years after the promulgation. To accommodate this range, the model assumes that all states will achieve compliance at the beginning of the first year the rule is effective, or two years after promulgation. Assuming promulgation in fall of 1995, the rule would be effective in fall of 1997. Based on data collected from the states, there has been significant lead-based paint activity (i.e., inspections, abatements, and training) taking place since 1992. Since the base data on number of structures with lead-based paint reflect conditions in 1990, the model adjusts these data to account for activities between 1990 and 1997. It is likely that the annual number of events has increased over the 1990 to 1997 period. Instead of estimating the number of events in each of these years, however, the analysis simplifies the problem by assuming no events in 1990 and 1991, and a constant number of events in each subsequent year. In other words, the analysis assumes that the number of lead-based paint activities between 1992 and 1997 were the same as they will be post-1997.

Interior Prevalence of Lead The proportion of housing units with lead-based paint was calculated from the *1990 HUD National Survey of Lead-Based Paint in Housing*. The HUD study, described in Appendix 4.C, estimated the total number of housing units with lead-based paint in each of the four U.S. Census Regions. Based on these data, Exhibit 4.1 illustrates the variation in the proportion of the housing stock with lead-based paint hazards across the four regions, where hazards are defined as lead-based paint (lead content of 1.0 mg/cm^2 or more) in deteriorated condition or in good condition on friction surfaces such as windows and door frames. As shown, in 1990 nearly 14.5 million homes had lead-based paint that posed a potential hazard.[7] The proportion of residential units ranged from 12 percent in the south (where residential units tend to be newer) to nearly 31 percent in the northeast (where units tend to be older).

Since no direct estimates of the prevalence of interior lead-based paint in child-occupied facilities are available, the analysis developed estimates of the prevalence of lead-based paint using survey data from the Department of Housing and Urban Development and the Department of Energy. The estimation procedures are presented in Appendix 4.D.

[7]The term "target housing" is defined in Title X as housing constructed prior to 1978. Data limitations, however, require the use of pre-1980 housing stock.

While several types of units are included in the category of child-occupied facilities, the major types are day care centers and elementary schools. The number of child-occupied facilities are estimated from a variety of sources. According to an analysis by Willer et al., there are approximately 80,000 day care centers (including both nonprofit facilities such as Head Start, public schools, religious and independents; and for-profit facilities). Day care facilities in homes (i.e., family day care) are not included in this number since they are included with target housing. Assuming that the prevalence of lead-based paint in these facilities is the same as that in public buildings in general, approximately 13,000 day care centers have lead-based paint hazards (see Exhibit 4.2).

Exhibit 4.1: National and Regional Estimates of the Prevalence of Lead-Based Paint Hazards in Housing in 1990 (Interior)

Census Region	Housing Units with Lead Hazards*	Number of Housing Units in 1990	Percentage of Housing Units with Lead Hazards
Northeast	5,188,000	16,828,000	30.8%
North Central	3,112,000	19,401,000	16.0%
South	3,264,000	26,558,000	12.3%
West	2,891,000	14,413,000	20.1%
TOTAL	14,455,000	77,200,000	18.7%

* Lead Hazards: Lead-based paint (XRF $\geq$ 1) in deteriorated condition and/or in good condition on friction surfaces (e.g., windows, doors). This is consistent with the §403 Guidance.

Source: 1990 U.S. Department of Housing and Urban Development *National Survey of Lead Based Paint in Housing*.

Exhibit 4.2: Prevalence of Lead-Based Paint Hazards in Child-Occupied Facilities in 1990			
Facility type	Total in 1990	Percent with Lead-Based Paint Hazards*	Total with Lead-Based Paint Hazards*
Day Care Centers	80,000	16.2%	12,960
Elementary Schools			
Public	59,757	16.2%	9,680
Private	8,249	16.2%	1,336
Total	148,006	16.2%	23,977

* Lead Hazards: Lead-based paint (XRF $\geq$ 1) in deteriorated condition and/or in good condition on friction surfaces (e.g., windows, doors). This is consistent with the §403 Guidance.
Sources of data: See text and Appendix 4.D.

In 1990, there were 59,757 public elementary schools in the United States (Bureau of the Census, 1992, Table No. 228). The number of private schools was estimated by applying the ratio of private to public school enrollment (4.1 million/29.7 million) to the number of public schools (Bureau of the Census, 1992, Table 215). On this basis, the number of private schools is 8,249. The estimated proportion of public buildings with interior lead-based paint was applied to public and private schools to estimate the number of schools with lead-based paint (see Exhibit 4.2). Therefore, about 11,000 public and private elementary schools have lead-based paint hazards, for a total of nearly 24,000 child-occupied facilities. This analysis assumes that due to the larger size and frequently more complex construction of child-occupied facilities, their lead activities require the time and labor resources equivalent to two target housing abatement jobs to eliminate the lead-based paint hazards.

Prevalence of Lead in Soil Based on the HUD survey, less than one-half of one percent (0.45 percent) of all residential units were found to have lead soil levels equal to or greater than 5,000 ppm. This same prevalence is assumed to apply to child-occupied facilities.

Exterior Prevalence of Lead (In Conjunction with Lead Contaminated Soil) If the exterior of a building is contaminated with lead-based paint, it may recontaminate the surrounding soil after a soil abatement. Therefore, exterior abatements are assumed to occur whenever there is a soil abatement and the exterior paint contains lead at greater than or equal to 1.0 mg/cm^2. Based on HUD data, all cases where the soil lead levels were equal to or greater than 5,000 ppm were found to have exterior lead concentrations equal to or greater than 1.0 mg/cm^2.

Annual Number of Initial Inspections, Lead Hazard Screens, and Risk Assessments Current industry practice is for property owners to hire an inspector to determine if their property has lead-based paint and/or needs an abatement; risk assessments, as EPA has defined them, are usually not performed. As part of §402(a), EPA is establishing three approaches to the identification of lead-based paint hazards. While none of these are mandatory, each provides a particular approach to the lead hazard identification process. An **inspection**, which can be conducted by a certified inspector or risk assessor, is a surface-by-surface investigation for the presence of lead-based paint. Inspectors do not make a judgement about the nature or severity of the lead hazard, but simply determine the presence of lead. A **lead hazard screen**, to be performed by a certified risk assessor, uses dust sampling and a visual survey to determine whether residences that are in good condition contain lead-based paint or lead contaminated dust. A lead hazard screen report will provide building owners with the results of the visual inspection and dust samples, and may contain a recommendation to conduct a complete risk assessment. A **risk assessment**, which also must be performed by a certified risk assessor, is an on-site investigation to determine the existence, nature, severity, and location of lead-based paint hazards. According to the §402(a) regulations, a lead hazard screen is not appropriate for units that are in deteriorated condition, while a risk assessment is appropriate. It is possible that a risk assessment may be conducted in units in good condition; however, this analysis assumes that lead hazard screens are performed when the paint is in good condition and risk assessments in units with paint in deteriorated condition. In addition to reporting the results of this investigation, the risk assessment report provides options for reducing lead-based paint hazards. While none of these three approaches are required, each one fulfills some, or all, of the lead identification role now served by an inspection. For this reason, it is anticipated that many inspections, as they are currently performed, will be replaced with lead hazard screening and/or risk assessments as defined in this rule.

The analysis assumes that under §402(a), the total number of inspections, lead hazard screens, and risk assessments combined will equal the number of inspections that would occur without the introduction of lead hazard screens and risk assessments. The number of inspections, risk assessments, and lead hazard screens for target housing and child-occupied facilities is estimated on the basis of the estimated inspection rate in Massachusetts (to determine the overall number of units where some form of lead identification will take place) and estimates of the prevalence of lead-based paint in deteriorated condition based on HUD data (to determine the split between lead hazard screens and risk assessments). As described below, the model assumes that certain units will receive inspections.

A lead inspection is less expensive than a lead hazard screen or a risk assessment, creating an economic advantage to having an inspection. Therefore, the model assumes that in dwellings with ten or more units, where many samples would need to be taken, a building owner would opt for an inspection in order to determine if and where lead is present. The model also assumes that some proportion of building owners with one to nine units would opt for this less expensive procedure; the model assumes 25 percent. As shown in Exhibit 4.3, the number of inspections is estimated by applying the Massachusetts inspection rate (0.0046) to the number of target housing units in buildings with 10 or more units as well as 25 percent of buildings with one to nine units (Bureau of the Census, American Housing Survey, 1990). Based on these estimates there will be approximately 114,500 inspections annually. Of these units that receive an inspection, an average 34.6 percent (i.e., overall prevalence of lead) will have lead present and the inspector will suggest that a lead hazard screen or risk assessment be performed. Although the building owner is not required to have a lead hazard screen or risk assessment performed at this time and may choose to go right to the abatement stage, there is no basis for modeling this behavior. Therefore, the model assumes that all of the units that are found to have lead will receive either a lead hazard screen or a risk assessment.

Exhibit 4.3: Number of Residential Lead Inspections per Year, Based on the Massachusetts Experience	
Total Number of Inspections in Massachusetts in 1992*	9,720
Total Number of Housing Units in MA in 1992	2,120,004
Inspection Rate	0.0046
Total Number of Residential Houses in Buildings with 10 or More Units in United States	7,826,425
Inspection Rate	0.0046
National Estimate of Residential Inspections (in Buildings with 10 or More Units)	**35,883**
25 percent of Residential Houses with 1-9 Units in United States	17,150,876
Inspection Rate	.0046
National Estimate of Residential Inspections (25% of 1-9 units)	**78,635**
Total Number of Inspections (10 or more units plus 25% of 1-9 units)	**114,518**
*Source: Massachusetts Department of Public Health, 1993	

As defined by the rule, the first step in a lead hazard screen and a risk assessment is to review all information collected by the inspector, if an inspection has been performed. Otherwise, the risk assessor will determine if a lead hazard is present. Based on the HUD data, 18.7 percent of the total housing stock will meet the definition of a lead hazard. If no lead hazard is found, the model assumes that the risk assessor will not perform the full lead hazard screen or risk assessment. Therefore this first step of the lead hazard screen or risk assessment is effectively an inspection. If a risk assessor determines that a lead hazard is present, either a lead hazard screen or a risk assessment will be performed. The decision to do one or the other is based on the risk assessors' judgement of the condition of the paint. If the risk assessor determines that the paint is in relatively good condition, a risk screen can be performed. If the risk assessor determines that the paint is in deteriorated condition, a full risk assessment should be performed.[8] The difference in the two procedures is that there are more extensive sampling and reporting requirements for a risk assessment. The model assumes that 76.1 percent of units have paint in good condition and thus are eligible for the less expensive lead hazard screen, and 23.9 percent have paint in deteriorated condition and receive a risk assessment. These percentages are based on the HUD data. A risk assessment should include testing for the presence of lead in exterior paint and soil, as well as interior paint and dust. If the soil is determined to contain lead, the risk assessment will include the exterior paint since lead in the exterior paint could recontaminate soil after abatement. Therefore, the presence of lead in exterior paint does not specifically increase the number of risk assessments conducted.

In the case of child-occupied facilities, such as schools and day care centers, the analysis assumes that an inspection will be performed first to determine if lead-based paint is present. If lead-based paint is found, the analysis assumes that a risk assessment is performed. Risk assessments are not mandatory, but given the high level of concern about exposure of children, and the related liability concerns, the analysis assumes that the fullest possible review will be performed. To the extent that lead hazard screens will be done instead, the costs of this rule will be reduced slightly. Based on the HUD data, there will be approximately 65,500 risk assessments and lead hazard screens completed in target housing and an estimated 500 risk assessments and lead hazard screens completed in child-occupied facilities per year.

Annual Number of Recurrent Inspections, Lead Hazard Screens and Risk Assessments As described above, there are two types of abatements covered by this rule: permanent abatements, which remove the lead from the unit, and relatively permanent abatements, which remove the lead hazard for at least 20 years. This second approach requires monitoring every 20 years, i.e., recurrent inspections, lead hazard screens, and risk assessments. The analysis assumes that the annual number of initial inspections, lead hazard screens, and risk assessments remains constant. In addition, starting in year 21 all units which undertook one of the relatively permanent abatement approaches in the first year (minus those demolished during the 20-year period) will be reexamined. Similarly, in year 22, units that undertook these relatively permanent abatements in year 2 will be reexamined. Since the analysis covers 50 years, in year 41 there is another increase in the number of inspections, lead hazard screens, and risk assessments. In addition to the constant number of initial hazard identification activities, the remaining units that undertook enclosure and/or encapsulation in year 1 and the additional ones in year 21 will need to be reexamined.

Annual Number of Initial Abatements In 1992, there were an estimated 14.3 million housing units with interior lead-based paint hazards, as defined in this analysis, in the

[8]The precise wording of the rule states that this distinction between risk assessment and risk screen should be based on the condition of the housing unit. Since the condition of the paint is likely to be closely correlated with the condition of the unit, paint condition is used as a surrogate measure.

nation. Based on the number of lead inspections, lead hazard screens, and risk assessments, approximately 65,500 housing units with lead-based paint hazards will be identified each year.

A comparison of the number of abatements performed in Massachusetts in 1992 to the number of abatements predicted, based on the number of inspections and the prevalence of lead-based paint hazards in Massachusetts, showed that about 84 percent of residential units identified as having lead hazards had an abatement. The Massachusetts data on number of abatements do include partial (i.e., abatements of components) as well as full abatements, but do not include interim measures (e.g., thorough cleaning of unit, including duct work). There are a variety of reasons why an owner would decide not to have the lead abated. The main reason is that the perceived risks do not justify the costs in the mind of the owner. Perhaps there are no young children in the building or the owner thinks that the children do not participate in activities that put them at risk. For example, the lead content may be very close to the acceptable level and the owner may believe that this is "not so bad." Alternatively, the owner may institute interim controls. This ratio of 84 percent of housing units with an identified lead hazard is used in the analysis to calculate the likely number of paint and soil abatements. Therefore, about 55,000 abatements are expected to occur each year nationally.

The analysis treats the decision to abate lead-based paint on the interior of buildings and the decision to abate lead-contaminated soil as independent events, depending on the presence and condition of the lead-based paint and the lead content of soil, respectively. The decision to abate lead-based paint on the exterior of a house, however, is based on the lead content of both the exterior paint and the soil. Because exterior paint can be a major source of lead in soil, an exterior paint abatement may be necessary to solve the soil problem. Therefore, both the soil and the exterior paint must warrant abatement for an exterior paint abatement to be done. If the exterior paint contains lead but the soil does not exceed the level of concern, the exterior paint will not be abated. This assumption is based on EPA risk analyses that indicate that exterior lead-based paint has little affect on residential exposure unless it is contaminating the soil.

Based on the HUD data, all housing units where lead concentrations in soil were equal to or greater than 5,000 ppm also had exterior lead-based paint. Therefore, the number of exterior abatements was estimated by multiplying the number of houses with both a lead soil problem and an exterior lead-based paint problem by the proportion expected to abate: the same 84 percent used in estimating the proportion of housing units with lead hazards that would have an abatement. Based on this calculation, there will be approximately 1,325 exterior abatement jobs in 1992, in the total of 55,506 interior and exterior residential abatements.

In the case of child-occupied facilities, the analysis assumes that 500 abatements will occur each year. This assumption is based on a small sample of states and counties that were able to provide information on the annual number of abatements in day care centers (excluding family day care) and elementary schools, and the number of child-occupied facilities (COF) in the relevant area.[9] Applying the weighted average ratio of abatements to the estimated number of child-occupied facilities yields an estimate of 435-491 abatements per year. Since several states acknowledged that they may not know of all COF abatements that had occurred because abatement firms are not required to report to the state, their estimates may be low. In addition, a couple of states said that they were financially constrained in terms of the number of inspections they performed. North Carolina, which has an explicit program to identify lead, has a much higher rate of abatement. This higher rate may be more reflective of attitudes and behaviors under Title IV. Therefore, the analysis assumes a number slightly higher than the range predicted by the available data.

This analysis further assumes that the 500 child-occupied facility abatements per year continue through each of the 50 years of analysis. Although there were slightly less than 24,000 COFs in 1990, the analysis assumes slightly more than 24,000 COFs will receive abatements over the 50 years covered by this analysis. This assumption was adopted because the stock of COFs is not constant over time. The number of day care facilities is expected to increase and new facilities may be started in old buildings containing lead-based paint. Likewise, COFs that relocate may move into buildings with lead-based paint. Offsetting these additions to the stock of day care centers with lead-based paint are potential relocations of facilities away from buildings with lead-based paint and attrition. Since the net effect of these changes are not known, and the discounted value of costs and benefits at the end of the 50-year period is relatively small, the analysis makes the simplifying assumption that there will be a constant number of abatements per year throughout the analysis.

Annual Number of Recurrent Abatements Since relatively permanent abatements are assumed to have a life of 20 years, these abatement activities will need to be repeated in the future. The analysis assumes that each year one-half of initial abatements use relatively permanent techniques. During the following 20 years, these units are demolished at the same rate as units in general (i.e., one-half of one percent a year). At the end of the 20-year period, the enclosure and/or encapsulation actions are repeated on the remaining units. Likewise, at the end of the next twenty years.

Soil Abatement The analysis estimates the costs and benefits from soil abatements where the soil will be abated if its lead concentrations are 5,000 ppm or greater. Based on the results of the HUD study, approximately 0.45 percent of housing units had soil that exceeded 5,000 ppm. The §403 guidance and this rule recommend abatement only if soil is bare. However, the data do not allow a differentiation between bare and covered soil. Since

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[9] States and counties providing information include: Rhode Island (5-10 per year out of 160 COF), Wisconsin (3 per year out of 1,300 COF), Maryland (1 elementary school out of a sample of 50), Los Angeles County (5 last year out of 504 COF), and North Carolina (25 out of 135 COF in Durham County). North Carolina requires the abatement of lead poisoning hazards in dwellings, schools and day care facilities determined to be the source of elevated blood lead in a child less than 6 years old.

soil abatements account for only a small proportion of total costs, the resulting overestimate is simply noted at this point.

The ratio of soil abatements performed to soil problems identified in target housing is assumed to be 84 percent. In other words, 84 percent of the housing units found to have a lead soil problem will actually abate the lead soil. Based on a soil abatement rate of 84 percent, there would be 1,325 soil abatements in 1998. For child-occupied facilities, 100 percent of soil problems (3 in 1998) are assumed to be abated.

Summary The number of lead-based paint events forecasted to occur in 1998 are shown on Exhibit 4.4.

Exhibit 4.4: Number of Initial Lead-Based Paint Events by Structure Type

	Number of Inspections	Number of Lead Hazard Screens and Risk Assessments	Number of Abatements*	Number of Soil Abatements
Target Housing				
Units in buildings with 1-9 units	78,635	58,819	49,822	1,189
Units in buildings with 10 or more units	35,883	6,710	5,684	136
Total Target Housing	**114,518**	**65,529**	**55,506**	**1,325**
Child-Occupied Facilities				
Day Care	900	270	270	2
Elementary Schools	767	230	230	1
Total Child-Occupied Facilities	**1,667**	**500**	**500**	**3**

* Interior and exterior abatements are counted separately. Therefore, one risk screen or risk assessment can produce two abatements.

4.3.2 Annual Demand for Trained Personnel

TSCA §402(a) will require that workers be trained in order to perform lead inspections, lead hazard screens and risk assessments, or abatement work. Estimates of the total number of people who will seek training were generated based on information from Massachusetts, the RLTCs, and judgments of industry contacts.

The Massachusetts lead abatement regulation was the first in the nation to require the registration and licensure of lead-based paint abatement personnel and lead-based paint inspectors. Since the Massachusetts regulations have been in effect since 1989, the Massachusetts situation can be viewed as a mature market. The Massachusetts experience provides one estimate of the magnitude of the "lead-based paint infrastructure" that will be created in response to the new regulations.

Below is a discussion, by discipline and structure type, of the estimated demand for trained personnel under the TSCA §402(a) requirements. For each discipline, the same training covers target housing and COFs. Separate estimates are presented to show the relative contribution of the two structure types. In several cases, Massachusetts estimates were used; however, data sources are provided within each section.

Inspector In 1992, there were 424 lead-based paint inspectors licensed in Massachusetts. These 424 inspectors completed 9,720 inspections, or an average of 23 per year per inspector. For a variety of reasons, assuming 23 inspections per year per inspector is likely to lead to an overestimation of the number of inspectors to be trained under §402(a). Under Massachusetts law, inspectors are required to conduct a more thorough inspection than EPA is requiring in the rulemaking. In addition, 23 inspections would not constitute full-ime employment. Information provided by industry representatives indicated that lead inspectors usually do not depend solely on lead inspections; rather, it is one aspect of their job. Industry representatives also stated that they felt there was an oversupply of inspectors in Massachusetts. Therefore, the analysis assumes that inspectors can complete 46 inspections per year, which is less than one per week. Based on the estimated 114,518 inspections, 2,490 inspectors will need to be trained. In addition, an estimated 1,667 inspections will be performed each year for COF, requiring 72 inspectors for a total of 2,562 inspectors (see Exhibit 4.5).[10]

Risk Assessors TSCA §402(a) will be the first federal or state lead-based paint law that explicitly recognizes the discipline of risk assessor, defines appropriate training requirements, and establishes certification procedures. As a result, there have been few training programs for risk assessors, and very little data on which to base an estimate of the demand for risk assessors.

EPA, however, outlines the specific requirements for risk assessor work. Based on the rule, a trained risk assessor is used under two circumstances: (1) to perform the risk assessment or lead hazard screen prior to abatement, and (2) to perform post-abatement clearances. Based on the specific tasks to be performed, the analysis assumes that, on

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[10]As stated earlier, the analysis assumes that the average COF lead-based paint event is twice as large and requires twice the personnel of an average target housing lead-based paint event.

average, a risk assessor could perform as many post-abatement clearance, lead hazard screens, and/or risk assessments in a year as an inspector can do inspections (46). The number of risk assessors needed is estimated to be 5,990 for target housing and 22 for child-occupied facilities, for a total of 6,012 risk assessors. As with inspectors and other disciplines, risk assessors can be trained to work in both target housing and child-occupied facilities.

Project Designer Much like risk assessors, project designers previously have not been required under existing federal laws. Since the project designer curriculum is in the development stages and only a few RLTCs are offering courses, not enough people have been trained to calculate a national estimate.

It is possible to make an estimate based on a few assumptions. First, there are likely to be fewer project designers than supervisors, since some target housing abatement jobs do not require a project designer. If fewer than 10 units are involved, this role can be filled by trained supervisors according to TSCA §402(a). Therefore, project designers are needed only for large jobs (10 units or more). In addition, since the project design is a more comprehensive plan than a risk assessment plan, it is not likely that a project designer could complete as many projects in a year as a risk assessor. For this analysis, it is assumed that a project designer would complete 23 jobs per year. Based on these assumptions, approximately 247 project designers will need to be trained for target housing, and 4 for child-occupied facilities, for a total of 251.

Supervisors (Paint Abatement) TSCA §402(a) requires the use of trained supervisors for abatement activities in all structure types. The analysis uses the OSHA estimate of 20 jobs per year per supervisor. As shown in Exhibit 4.5, there will need to be approximately 2,775 trained supervisors for target housing abatement work, and 50 child-occupied facility supervisors, for a total of 2,825 supervisors.

Since 20 jobs per year based on OSHA data appears to be low, data from Massachusetts were examined for a comparison. Massachusetts differentiates between contractors and supervisors; contractors are required to take additional training and are able to employ personnel. For the purposes of this analysis, supervisors and contractors are combined into one category resulting in 1,180 contractor/supervisors in 1994. In 1994, there were 4,347 abatements in Massachusetts. Dividing this by the 1,180 contractors/supervisors yields, on average, 3.7 jobs per year. For a variety of reasons, however, this is likely to yield a substantial overestimate of the demand for contractor/supervisors. Since each project typically takes about one week, it is likely that abatement contractor/supervisors could absorb a substantial increase in demand for their services. In addition, Massachusetts state officials and abatement firms report that during the recessionary period of 1992-94, there was an oversupply of contractor/supervisors in the state. Also, Massachusetts officials indicated that many homeowners/landlords get trained as supervisors in order to perform lead abatement activities on their property, but are not in the business of performing lead abatements. For these reasons, the OSHA number of 20 jobs per year appears to be reasonable.

Supervisors (Soil Abatement) While the average soil abatement takes fewer days to complete than the average paint abatement, soil abatements cannot be performed during all times of the year since they involve outside work. Since more specific data are not available, the analysis assumes that a supervisor will do 10 soil abatements per year. This number is half as many soil abatement jobs a year as he/she could do residential paint abatements. Based on the approximately 1,325 residential soil abatements of soil with lead concentrations of 5,000 ppm or more, there would need to be 132 soil abatement supervisors for target housing. If 20 soil abatements per year were assumed, the resulting demand for supervisors would be 66 for the entire nation. This would not provide a reasonable geographic distribution of trained soil abatement supervisors. The demand for trained soil abatement supervisors for child-occupied facilities increases total demand by 1, resulting in a total demand of 133 supervisors for both structures.

Workers Estimates for the number of workers to be trained used workload assumptions similar to those used for supervisors. Based on industry information, on average there are two workers for every supervisor. As shown in Exhibit 4.5, approximately, 5,550 trained workers will need to be available for target housing abatement, and 100 for child-occupied facilities, for a total of 5,651 workers.

Workers (Soil Abatement) Based on discussions with industry, the typical soil abatement crew consists of three people, one supervisor and two workers. Therefore, twice as many workers will be trained as supervisors for soil abatement. In other words, 265 target housing soil abatement workers will be trained and 2 child-occupied facility soil abatement workers for a total of 267 workers.

Summary The preceding discussions have presented estimates of the demand for trained personnel under Title IV, based on predicted 1997 levels of activity. Exhibit 4.5 summarizes these numbers. While soil abatement and paint abatement supervisors receive the same training, and likewise for workers, the demand is estimated separately since soil and paint abatements are likely to draw on different pools of personnel.

Exhibit 4.5: Demand for Trained Personnel, by Structure Type and Discipline

	Number of Inspectors	Number of Risk Assessors	Number of Project Designers	Number of Supervisors	Number of Workers
Target Housing	2,490	5,990	247	2,775	5,551
Child-Occupied Facilities	72	22	4	50	100
Total	2,562	6,012	251	2,825	5,651
Target Housing — Soil Abatements	N/A	N/A	N/A	132	265
Child-Occupied Facilities — Soil Abatements	N/A	N/A	N/A	1	2
Total — Soil Abatements				133	267

Appendix 4.A. Impact of Rule on Abandonment Rates

In addressing the question of whether this rule will increase rates of abandonment, key characteristics of the rule must be kept in mind. First, abatements are **voluntary** under TSCA §402(a). This rule does not mandate any lead-based paint activities. Instead, it seeks to ensure that when a lead-based paint activity is conducted, it is appropriate and of high quality, by requiring proper training for personnel and by specifying work practices. With growing consumer awareness of the hazards resulting from exposure to lead, the demand for housing that does not pose lead hazards will increase and the price consumers are willing to pay will also increase, or consumers will settle for less expensive means (i.e., interim controls) to reduce lead hazards. At the same time, there will be differences in demand among consumer groups, due to the likely beneficiaries (families with young children are more likely to value a unit free of lead hazards than a household without children, all other things being equal). One likely result of TSCA §402(a) is the creation of a submarket of housing units free of lead hazards, with a demand curve higher than the demand curve of units that have lead hazards. There will also be an upward shift in the supply curve due to the training and work practice requirements of this rule. The number of housing units that shift to the lead-free submarket depends on the changes in demand *relative* to the costs of creating a unit free of lead hazards. The increase in costs of lead-based paint activities, therefore, may result in fewer units moving into the hazard-free submarket than would be the case if growing consumer awareness were not accompanied by cost increases. This does not necessarily mean, however, that units will be abandoned. They may stay in the market of units with lead hazards. If, however, the supply in this market decreases less than the decrease in demand, at the margin some housing stock that would otherwise be viable property may get squeezed out of the market.

A somewhat different situation may exist where abatements are **required** by state law or local ordinance. If abatements are mandatory, then abandonments are more likely to occur because the third option (doing nothing) does not exist. Under these circumstances, if the full cost of paint abatements cannot be passed along to the ultimate consumers, then landlords may abandon the property in order to avoid the costs. A similar situation may occur in the face of increased liability concerns. If abatement is necessary to avoid liability, but abatement costs cannot be recovered, the landlord is faced with a reduction in the value of the property and may choose to abandon it.

Little empirical work is available on the size of changes in abandonment rates due to costs of complying with lead-related regulations. According to one study of mandatory abatements in Baltimore, the city's annual report stated that, "the threat of abatement by city crews for noncompliance resulted in dramatic behavior change in property owners. Some 98 percent of the property owners started work on the specified date."[1] No cases of abandonment in the face of required abatement were reported. Moreover, based on their

[1]Ford, Deborah Ann and Michele Gilligan, "The Effect of Lead Paint Abatement Laws on Rental Property Values," *AREUEA Journal*, Vol. 16, No. 1, 1988.

statistical analysis of the Baltimore housing market in the mid-80s, Ford and Gilligan found evidence that mandatory abatements would infrequently, if ever, lead to property abandonment. Voluntary abatements under TSCA §402(a), even if partially motivated by liability concerns, would be even less likely to lead to abandonments than mandatory programs.

A recent paper prepared by Fraas and Lutter (1996) compares the effect of property tax increases on abandonment rates to the effect of lead-based paint regulations on abandonment rates.[2] It argues that the elasticity of abandonment due to taxes (i.e., the percentage change in number of abandonments divided by the percentage change in taxes) can be applied to the cost of abatements to estimate the percentage change in abandonment rates resulting from mandatory lead-based paint regulations. The paper cites studies that estimate this elasticity using tax delinquency as their indicator of abandonment. In other words, these studies use data on the number of properties failing to pay property taxes as a proxy for number of properties abandoned.

Measuring the relationship between an increase in the costs of operating and maintaining real estate and rates of abandonment is complicated by the problem of defining abandonment. Abandonment is a physical act and the end result is readily recognizable, a boarded-up or gutted building which is uninhabitable. However, relatively few of the units that pass through stages of tax delinquency or foreclosure actually end up abandoned. The primary reason for this is that there are many opportunities during the years following the cessation of tax payments during which an owner can redeem the property or it can be sold to another owner. Despite the failure to pay taxes the property usually continues to be inhabited. Financial decisions, such as tax delinquency, foreclosure and forfeiture, are choices about how to distribute capital losses and typically do not result in abandonment.

It is likely that the elasticity of tax delinquency with respect to tax assessments greatly overestimates the elasticity of abandonment with respect to regulations such as §402. As presented in his article on option values, O'Flaherty argues that owners of low quality units are sensitive to the level of taxes.[3] Property value fluctuations create uncertainty in the minds of owners about the future value of their holdings. An owner with very little equity in a property can effectively secure an option on the future value of the property (i.e., reduce the cost of uncertainty) by withholding tax payments. If the value of the property goes up then the owner "exercises the option" by redeeming the property and capturing an appreciation in equity. If the value of the property falls the owner can "let the option lapse," forfeiting the property to the city and saving the expense of several years of accumulated property taxes. In effect an owner can use tax delinquency to reduce the cost he would incur

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[2] Arthur Fraas and Randall Lutter (1996), "Abandonment of Residential Housing and the Abatement of Lead Paint Hazards," *Journal of Policy Analysis and Management*, Vol. 15, No. 3, 424-429.

[3] Brendan O'Flaherty (1990), "The Option Value of Tax Delinquency: Theory," *Journal of Urban Economics*, 28, 287-317.

if neighborhood conditions deteriorate, without losing the benefit if neighborhood conditions improve. The larger the property taxes and the longer the redemption period, the more valuable is the tax delinquency option. Therefore an increase in tax assessments makes it financially rational for more property owners to "buy" an option on the uncertain future value of their property via tax delinquency.

Second, tax delinquent properties are not necessarily abandoned. There are many courses that these properties take. In general, cities do not have the money or expertise to manage many diverse and low quality properties. So city managers go to great lengths to avoid becoming the owners of last resort. One approach is to be quite lenient in the amount of time that a city allows the owners to pay past taxes prior to foreclosure on the property, in the hopes that the owner will pay the past taxes. Another approach is to accept reduced or partial payment of the taxes. As long as there is a reasonable chance that the taxes will be paid, a city can carry the unpaid taxes as an asset on their books. A city having trouble balancing its books would rather hang onto the asset by deferring foreclosure than realize the loss. Another common approach is to auction the property to recoup past taxes. Often the owner redeems the property just before public auction. However, some cities allow the former owner to repurchase the property, shedding the unpaid tax liability and effectively sharing the capital loss with the city. The key point is that there are many opportunities for a property to be redeemed or sold to a new owner such that tax delinquent properties do not become abandoned properties. An estimate of the tax delinquency elasticity may represent the increased cycling through delinquency that would occur with a tax increase even though the rate of eventual abandonment is unaffected.

Another concern is estimating the value of the externality created by abandoned buildings. Although it is reasonable to think of urban blight in terms of a contagion effect, the externality generated by abandoned buildings is a second order effect and there is not even reliable data on the size of the first order effect of abandonment. Neither demolition nor removals accurately measures abandonment. Since demolition is costly, usually a property gets demolished only when a developer is ready to rebuild or when public outcry causes the city to demolish. Removals from the housing stock are an even more generic term; removals include any change in the use of the building. Moreover, removals is the residual category so that measurement errors from other categories affect the number of removals. In other words, reliable data on either abandonment or the secondary impacts of abandonment are not available.

Finally, consumers are expected to value lead abatement. Theoretically, this demand should raise the rents and value of lead abated units. Based on discussions with knowledgeable observers, however, there is no discernible difference in rents between lead-free units and units with lead-based paint at this time.[4] Perhaps more careful measurement could pick out the distinction. However, it appears that other forces of supply and demand

[4]Nick Farr of The National Center for Lead-Safe Housing.

are driving the rental market. It is likely that changes in property values are also driven by forces other than a marginal increase in the cost of a future abatement such that decisions about abandonment are not sensitive to modest changes in the cost of lead abatement. For all of these reasons, this analysis does not directly incorporate potential abandonments due to this rule, and the demolition rate used in the analysis is based on historical experience.

Appendix 4.B. Review of Massachusetts Lead Poisoning Regulations

This section provides a summary of the Massachusetts Lead Poisoning Regulations (105 CMR 460.000 and 454 CMR 22.00). The data from the Massachusetts lead abatement experience is used extensively in the cost and benefit analysis of section 402 (a) and (b) of Title IV. This summary serves to highlight areas where the Massachusetts regulations are similar, or different, from the Title IV regulations. To the extent that the Massachusetts regulations use different terms to define similar activities or actions as Title IV, the Title IV terminology was used.

In addition to voluntary inspections and lead abatements, activities can be triggered by two events in Massachusetts: 1) elevated blood lead in children, or 2) as a part of a sanitary code inspection. Most inspections and abatements in Massachusetts, however, are not required.

B.1

The following describes the Massachusetts lead identification and abatement regulations and compares them to the requirements under Title IV.

Early Diagnosis (Screening) Program

Unlike TSCA Title IV, the Massachusetts regulations establish an early diagnosis screening program requiring that all children under the age of six be regularly tested for lead poisoning. These tests are to be conducted by healthcare providers at regular intervals. Children are considered to be lead poisoned if their blood lead levels is 25 µg/dl or greater. As described below, abatements are mandatory in case of lead poisoning. In addition to regular screening, children are assessed to determine whether or not they are at high risk for lead poisoning. The criteria used in Massachusetts to determine a high risk for lead poisoning include:

1) living in housing constructed prior to 1978 containing paint in poor condition (i.e., peeling, chipping, or flaking paint, or broken or crumbling plaster),

2) living near a lead smelting or processing plant or other point sources of lead contamination, or having household members who work in lead-related occupations,

3) having siblings, housemates, or playmates who are lead poisoned, or

4) living in housing constructed prior to 1978 which is undergoing renovation significantly likely to disrupt painted surfaces.

Children who are determined to be at high risk of lead poisoning must be screened every six months between the ages of six months to 36 months, annually between the ages of 37 months and 72 months. Children who do not meet any high risk criteria must be tested annually until the age of 48 months. All children must show evidence of being previously screened for lead poisoning before entering kindergarten. Results of the lead screen need to be reported to the state program within a week of the testing.

Inspection

Inspections are intended to be a surface by surface inspection for the presence of lead. All surfaces must be tested for the presence of lead to ensure that all surfaces with lead-based paint are detected, and that all surfaces without are detected so that building owners do not undertake the expense of unnecessary abatement. Inspections are to be conducted using one of the following methods:

- Mobile XRF analyzer - readings of greater than 1.2 mg/cm indicates the presence of dangerous levels of lead.

- 6-8 percent sodium sulfide solution - any color (grey or black) change indicates the presence of dangerous level of lead.

The Massachusetts regulation suggests, but does not require, using a combination of methods for more precise results. Inspectors are required to fill out a written report which includes the following information: a diagram of the unit, results of the tests for each surface in each interior room tested, results of the tests for each exterior surface tested. Inspectors must provide the owner, tenants, and state authorities with a copy of the inspection report. If a unit tests positive for the presence of lead, inspectors must notify the appropriate authorities.

Unlike Title IV, under Massachusetts regulations, a lead inspection may include an assessment of the suitability of encapsulation, including substrate and coating conditions and functions in regard to impact, friction, abrasion, weathering, or other factors. Upon the request of the owner, the lead inspection shall include a designation of all low-risk abatement and/or containment activities that may be conducted by an owner or owner's agent. In these respects, an inspection under the Massachusetts regulation is more like a lead hazard screen or risk assessment under Title IV.

Abating Dangerous Levels of Lead

The owners of a dwelling are required to remove or cover any paint, plaster, or other accessible materials containing dangerous levels of lead whenever:

1) a child under six years of age resides therein, whether or not the residential premises have been inspected; or

2) the owner(s) receive an order to delead because a child under six years of age resides therein or a child under six years of age who is lead poisoned has resided there within the past twelve months.

Abatement Requirements

The Massachusetts lead poisoning regulations require that the removal or covering of lead-based paint or other such material be performed as follows:

1) All peeling of loose lead-based paint, plaster, or putty on both interior and exterior surfaces and fixtures shall be removed or adequately covered, or the fixture or surface replaced.

2) Windows with sills five feet or less from the floor must have all lead-based paint and putty removed from all surfaces that are either movable or come in contact with movable surfaces. Alternatively, the surfaces may be covered where feasible, or the window and/or sill may be replaced.

3) Intact paint, plaster, or putty shall be removed on accessible, mouthable surfaces below five feet and four inches from the ground. Alternatively, the surfaces may be covered or replaced.

4) Lead-contaminated soil shall be abated in compliance with regulations promulgated by the Department of Environmental Quality Engineering.

Under the Massachusetts regulations, repainting with non-lead-based paint without the removal or covering of the offending paint, plaster of other material, does not constitute compliance.

Methods of Removal

Loose paint, putty, plaster or intact paint on window surfaces and on accessible, mouthable surfaces must be removed down to bare wood or other substrate. The following methods are the only permissible methods for the removal of lead-based paint in Massachusetts:

1) Wire brushing or dry-scraping alone or with the aid of non-flammable solvent or abrasive compound not containing methylene chloride,
2) Hand scraping or machine sanding with HEPA exhaust,
3) Controlled, low-level heating element with temperatures below 1,000 fahrenheit,
4) Dip-tank solvent (off-site),
5) For exterior use only, abrasive blasting using wet-misting technique or simultaneous system.

The following methods are specifically prohibitive for use in lead-based paint removal:

1) Torch or flame burning,
2) Dry abrasive blasting using sand, grit or any other particulate,
3) On-site use of methylene chloride or methylene chloride solutions,
4) Use of potassium or sodium hydroxide-based solutions except in paste forms,
5) Machine sanding except as sanding with HEPA exhaust.

All leaded materials shall be disposed of in accordance with applicable regulations, and all HUD and EPA regulations shall be followed.

Pre-Abatement Notification

Contractors are required to give a minimum of five days advance notice of: the date the deleading will begin, the estimated completion date, and the method of abatement. Notice must be given to the following individuals and agencies:

- Occupants of the dwelling to be abated
- All other occupants of the building
- The local board of health or enforcement agency
- The Department of Labor and Industries
- The director
- The owner of the property

Note that it is the property owners responsibility to ensure that the contractor complies with the notification requirements.

Safety Precautions and Post-Abatement Clean-up Procedures

During and upon the completion of an abatement, the Massachusetts regulations requires that the following procedures be followed.

1) No persons shall occupy a unit while removal or covering of lead hazards or replacement of painted surfaces is taking place. Household pets are not allowed to remain in the unit.

2) Deleaders and inspectors shall adhere to all safety, health, and blood lead monitoring requirements.

3) All wall-to-wall carpeting shall be covered with two sheets of plastic (six mils thickness minimum), secured to wall or baseboards with masking tape.

4) the final clean-up must be performed by the contractors no sooner than 24 hours after the completion of active deleading. The final clean-up shall consist at a minimum of a HEPA filtered vacuuming of all interior surfaces exposed to deleading, window sills in their entirety, and porches deleaded or exposed to deleading, followed by wet mopping/sponging of the same surfaces with a solution of tri-sodium phosphate and a second HEPA filtered vacuuming.

5) Occupants may resume occupancy only upon determination by a lead inspector, using a copy of the initial inspection report, that the unit has successfully met the conditions of reoccupancy (see section below).

Post-Abatement Dust Sampling

Under Massachusetts law, inspectors perform the post-abatement clearance testing. The surfaces to be tested for the presence of lead hazards include but are not limited to floors, windows sills and window troughs of two or more designated rooms. A unit is considered to have safe levels of lead if the floor dust levels are below 200 micrograms per square foot, window sill dust lead levels are below 500 micrograms per square foot, and window trough lead dust levels are below 800 micrograms per square foot.

B.2. Training Licensure, Registration and Monitoring of Lead Professionals

Effective July 1, 1990 (January 1, 1989 for contractors and supervisors) only licensed or certified individuals are able to conduct lead inspections or lead abatements. Massachusetts currently certifies/licenses inspectors, contractors, and supervisors. Workers must be trained but are not certified by the state. The Massachusetts law does not require training or certification of risk assessors or project designers. The requirements of each category of lead professional in Massachusetts are summarized below.

Inspectors

There are four categories of lead-based paint inspectors, as follows:

Provisional lead-based paint inspectors: May conduct lead-based paint inspections and determinations only under the direct supervision of a Master lead-based paint inspector. Provisional lead-based paint inspectors must complete an apprenticeship consisting of 15 full inspections before becoming a lead-based paint inspector

Lead-based paint inspector: May conduct lead-based paint inspections and determinations without direct supervision, but may not supervise provisional lead-based paint inspectors.

Master lead-based paint inspectors: May conduct lead-based paint inspections and determinations independently, and may supervise the work of provisional lead-based paint inspectors. In order to keep his/her status as a Master lead-based paint inspector, he/she must be willing to train apprentices who seek their services.

Code enforcement inspectors: May conduct lead-based paint inspections and determinations without direct supervision, and can carry out all code enforcement activities. They may not supervise provisional lead inspectors.

The training requirements for the four categories of inspectors are similar. Distinctions between the three categories are based on age, skill proficiency, and experience. The training course requirements are summarized below. Licenses must be renewed annually.

Lead-Based Paint Inspector Training Requirements

Under the Massachusetts law inspectors are required to complete a 3-day training which includes a combination of classroom and hands-on activities. Students are required to pass a written exam with a grade of 70 percent of better; a grade of 90 percent of better is required for students who wish to eligible for a Master lead inspector's license. At a minimum the following topics must be covered in the lead-based paint inspector and Master lead-based paint inspector course: history of lead poisoning, health effects, sources of lead in the environment, lead poisoning prevention, tenant/owner rights, notification requirements, conducting the initial inspection, lead determinations, proper deleading procedures, conducting reinspection, ethical considerations, and federal and state laws. Certification for code enforcement inspectors include additional topics relevant to their job specific responsibilities. Section 2.1 describes the curriculum requirements in further detail. License must be renewed annually.

Worker (referred to as Deleader in Massachusetts regulations)

Effective July 1, 1990 any worker conducting lead abatement activities must be trained by a certified training provider. However, deleaders are not required to be certified with the state.

Deleader Training Requirements

Under Massachusetts law, deleaders are required to complete 2 1/2 days of training. the training must be a combination of classroom and hands-on activities, and trainees need to pass a written exam by a grade of 70 percent of better. The curriculum for deleader training must include: safe work practices, health risks, precautionary measures, personal protective devices, prevention of contamination, and medical monitoring. Section 2.1 describes the curriculum requirements in further detail.

Contractors and Supervisors

Effective January 1, 1989 only those contractors and supervisors who are certified can engage in abatement operations. The training requirements for contractors and supervisors are similar; however, only contractors are able hire deleaders to work under him/her. Supervisors and/or contractors are responsible for ensuring the safety of the work area and that all state and federal regulations are complied with.

Contractor/Supervisor Training Requirements

Under Massachusetts law, supervisors must complete three days of training, and contractors must complete four days. The training must be a combination of classroom and hands-on activities, and trainees need to pass the written exam by a grade of 70 percent of better. The curriculum for supervisor training must include all information in the deleader course, as well as information on: regulatory requirements, supervisory training, lead inspection reports, and disposal requirements. Contractor training must include all information covered in deleader and supervisor training, as well as insurance and liability issues, and recordkeeping issues. Section 2.1 describes that training requirements in further detail. Licenses must be renewed annually.

Appendix 4.C. Households with Lead-Based Paint

In order to estimate the market demand for lead inspection and abatement in distinct areas of the country, the number of housing units containing lead-based paint was calculated for each region of the United States. The data used for the analysis was derived from a national survey sponsored by the U.S. Department of Housing and Urban Development (HUD) (U.S. Department of Housing and Urban Development, 1990). The survey was conducted between December 1989 and March 1990. The HUD survey included 284 owned homes and 97 public housing units in 30 counties across the nation. The counties were selected to represent the total housing inventory in the United States. Only data on privately owned housing were used in this analysis.

HUD estimated that at the time the survey was conducted, there were approximately 77 million pre-1980 housing units in the U.S. The focus of the HUD survey on pre-1980 units reflects the ban on the use of lead-based paint for target housing purposes in 1978 by the Consumer Product Safety Commission acting under the authority of the Consumer Product Safety Act.

HUD surveyed a sample of 284 privately owned residential units. The sample design of the HUD survey involved a stratification of the pre-1980 housing stock into six groups reflecting three construction-period categories (pre-1940, 1940-1959, and 1960-1979) and two dwelling types (single family and multifamily). To adjust for disproportionate sampling within these six strata, as well as to correct for recognized disproportionate sampling with respect to census region and presence/absence of children under age 7, the 284 HUD samples were given "weights" by HUD so that the results could be extrapolated from the 284 samples to the total 77 million pre-1980 units nationally. These HUD-specified weights were used in the risk assessment modeling performed here, with additional adjustments made to them as described later to accommodate the post-1980 housing stock.

The HUD survey took lead measurements of interior and exterior paint, exterior soil, and interior dust at each of the 284 sample units. Measurements of lead in these media were made at several locations and surfaces in each sample residence. Other information relevant to assessing exposure to lead in these units was also obtained, such as the existence and extent of damaged paint. The following briefly describes how these HUD measurement data were used to characterize the change in exposure potential from §§402(a) and 404.

Lead in Paint The most commonly used method to measure the level of lead on painted surfaces in residences is the XRF (X-ray fluorescence) technique, which measures lead in paint present on surfaces in units of mg/cm^2. It should be noted that because of limitations in this analytical method, low levels of lead-based paint reported by XRF measurements (for example, in the range of approximately 1.0 mg/cm^2 or less) are considered much less reliable than are higher readings. For the purposes of this model, XRF readings of 1.0 mg/cm^2 were used as the cut-off to distinguish between residential units with and without lead-based paint. That is, units having reported XRF measurements of 0.99 mg/cm^2 or lower were considered to be free of lead-based paint.

The HUD survey took interior XRF readings at several locations in each dwelling, including one randomly selected "wet room" (i.e., rooms having plumbing such as a kitchen or bathroom) and one randomly selected "dry room". Measurements were made on several substrates within those rooms, such as walls, ceilings, windows, molding, door systems, and shelves. The value characterizing potential exposure to lead from paint in the sample dwelling is the maximum measured interior XRF value. The maximum interior XRF level is the most frequently used measure to characterize lead-based paint levels in studies involving lead exposure from target housing paint.

HUD also collected data on the XRF value for exterior paint. This information was used only in the abatement cost analysis, to identify those residential units undertaking soil abatement that would also require exterior paint abatement to insure that the soil abatement is fully and permanently effective. Exterior lead-based paint (if present) is assumed to be a source of lead in soil at houses with high soil lead levels. Treating the soil without removing a potential source of the lead could result in a reoccurrence of the high soil lead levels. Exterior lead-based paint information was also used, along with the interior paint reading, to identify lead-free units for the adjusting of weighting factors discussed below to simulate changes in future characteristics of the housing stock.

The HUD survey also provided information on the condition of the lead-based paint in these dwellings. For the purposes of this analysis, housing units reported to have more than 5 square feet of damaged interior lead-based paint were classified as "deteriorated condition" units, as discussed below. Twenty-four percent of the housing units in the HUD survey have paint in bad condition.

Lead in Soil In the HUD survey, target housing soil readings were taken near the entrance to the residence, at the drip line, and at a remote location. Soil lead measurements were reported in parts per million (ppm)[5]. To be most representative of the overall levels to which children are exposed, the arithmetic average of all the individual soil lead content measurements taken at a HUD sample house is used to characterize the lead exposure from soil.

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[5]The HUD report (Appendix II, Chapter 3) discusses a trimming procedure applied to individual soil samples. Certain soil samples were very high. The HUD report says that "Although there is no reason to believe that the large readings were not factual", individual soil samples with lead levels over 2,600 ppm were trimmed from the data set, as such high readings were not required for the main HUD analysis. If a similar procedure were to be adopted for the §402 analysis, there would obviously be no remaining residential units with a minimum soil level over 5,000 ppm. This would lead to an underestimate of both the costs of the rule (as soil abatements are assumed to only occur for soil levels exceeding 5,000 ppm) and the benefits. As HUD concluded that the high soil samples were not inaccurate, these high individual samples were retained in the §402 analysis in order to provide a basis for estimating the prevalence of high lead levels in soil, and the benefits of soil abatements.

Lead in Dust As described in Chapter 6, lead in dust is a crucial component of the analysis of children's blood lead levels. Although dust levels are not directly considered in the definition of the eligible housing (defined on paint lead content level, condition and soil lead level), the risk model assumes dust is one of two pathways that lead from both paint and soil are taken into children. Direct ingestion of paint (i.e., pica) is the other pathway.

In the HUD survey, floor dust lead concentrations (in ppm) were obtained for a wet room, dry room, and at the entry way of each housing unit. The arithmetic mean of these measurements was used to characterize the floor dust concentration for each HUD sample unit[6]. Dust lead measurements were also taken for window troughs and window sills, but were not used in the averaging. Measurements were also taken in the HUD study of dust loadings, reported in units of $\mu g/ft^2$. However, the model for predicting blood lead levels from exposure to dust (as described in Chapter 6) requires dust concentrations, and cannot use dust loading values directly.

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[6]The HUD report (Appendix II, Chapter 3) describes a trimming procedure used to eliminate unusually high individual dust samples. The very high samples may represent errors in data entry or recording, or in the laboratory results. The HUD report concluded that eliminating individual dust values with lead levels over 100,000 ppm was warranted. The §402 analysis used a similar procedure to trim the sample dust data. Neither trimming procedure resulted in any individual residential unit being eliminated from the sample: individual anomalous dust samples were eliminated, and the remaining samples were used to determine an average dust level in each sample residence.

Appendix 4.D. Estimating the Prevalence of Lead-Based Paint in Child-Occupied Facilities and Public Buildings

The analysis assumes that all buildings constructed in the same year have an equal likelihood of containing lead-based paint. The basis for this assumption is that while lead levels in paint changed from year to year, there are national markets for paint and the lead content at any given time is likely to be approximately the same across the country. This assumption does not allow for repainting done more recently using paint with lower lead content. If the original paint were left in place, however, and the new paint applied over it, then abatement would still be needed since the lead is still present.

Based on this assumption, data on the prevalence of lead-based paint in residential units was used to estimate the prevalence of lead-based paint in public buildings. The numbers of public buildings in each category was estimated from the 1989 U.S. Department of Energy *Commercial Building Energy Consumption Survey* (DOE CBECS). The building counts include public buildings (e.g., buildings that are accessible to the public) built before 1990. To estimate the number of public buildings with lead-based paint, the proportion of housing units with lead-based paint in a given year is multiplied by the total number of public buildings built in that year (see Exhibit 4.D.1). Due to the high level of concern about lead in facilities such as schools and day care centers, the analysis assumes that any lead-based paint in these facilities will be abated regardless of condition. Therefore, the condition of paint was not considered when calculating prevalence. Approximately 30.0 percent of public buildings have lead-based paint with lead content greater than or equal to 1.0 mg/cm^2. Since older buildings are more likely to be demolished than newer ones, the prevalence of lead is likely to decline over time.

Exhibit 4.D.1: Prevalence of Lead-Based Paint in Child-Occupied Facilities and Public Buildings (Interior)

Year Constructed	Total Number of Buildings*	Expected % With Lead**	Expected # With Lead
1899 or before	125,371	100.0%	125,371
1900 to 1919	155,982	60.9%	94,993
1920 to 1945	467,017	34.9%	162,989
1946 to 1959	614,229	39.1%	240,164
1960 to 1969	537,486	32.7%	175,758
1970 to 1979	602,086	17.4%	104,763
1980 to 1990	508,000	0.0%	0
Total	3,010,171	30.0%	904,037

* Source: 1989 U.S. Department of Energy Commercial Building Energy Consumption Survey.

** Source: 1990 U.S. Department of Housing and Urban Development National Survey of Lead Based Paint in Housing.

5. Cost of the Regulation

This chapter presents the estimated costs of §§402(a) and 404 of Title IV of the Toxic Substances Control Act (TSCA). It starts by describing the methodology and the data used in estimating the costs. This is followed by the cost estimates. The specific requirements of this regulation are described in Chapter 3.

For purposes of this analysis, the costs have been grouped into three categories, corresponding to three types of recommendations presented in §§402(a) and 404:

- **Work Practice Standards:** Costs resulting from the imposition of reliable, effective and safe standards for performing lead-based paint activities;

- **Training, Accreditation, and Certification Requirements:** Costs resulting from the training and certification requirements (including the accreditation of training providers) for lead-based paint inspection, risk assessment, and abatement personnel; and

- **Program Administration:** Costs of establishing and operating State, Indian Tribe, or Federal programs to administer, monitor, and enforce the standards, regulations, or other requirements established under §402 (a).

In all three categories, the costs are a function of: (1) the number of lead-based paint events (e.g., inspections, risk assessments, abatements) that will occur, (2) the number of demanded trained and certified personnel to perform the LBP events, and (3) the specific requirements and recommendations of §402(a) (e.g., hours of training, number of dust samples). Since other sections of Title IV may increase the number of inspections and abatements by increasing the information readily available to owners and purchasers/renters of property regarding the potential hazards of lead-based paint, the costs as well as the benefits may be underestimated in this analysis. Since the costs and benefits per housing unit abated will not change with changes in the level of activities, costs and benefits would go up more or less together.

The first of the following sections provides an overview of the methods used to estimate the cost of the regulation. This is followed by sections that present estimates of the incremental unit costs resulting from the work practice standards and the training and testing requirements. By applying these unit costs to the relevant measures of activity (e.g., incremental abatement costs multiplied by number of abatements, incremental worker training costs multiplied by numbers of workers to be trained) estimated in Chapter 4, the costs of the standards and training provisions are determined. This is followed by an estimate of the cost to administer the programs. The final section of this chapter provides a summary of all the cost estimates.

5.1 Overview of the Methodology

The preferred measure of societal costs would be the opportunity cost (i.e., the goods and services foregone) of resources devoted to the activities mandated by the rule, including any loss in producer or consumer surplus. These are the value of the "goods" that society forgoes in order to reduce risks associated with exposure to lead-based paint hazards. The available data, however, do not allow for a direct estimation of the opportunity costs. Out-of-pocket costs, therefore, are used in this analysis as a surrogate measure, which in some instances may result in an overestimate. For example, training costs are estimated to be equal to tuition costs plus lost wages for the hours the trainee spends in training plus incidental costs such as travel and per diem expenses. In other words, these estimates are based on the assumption that tuition costs cover the entire cost to the training providers (including their profit) and that wages are a good measure of the value of the time spent in training. If trainees would be otherwise unemployed, however, wages are a poor proxy for the value of their time. In addition, the use of out-of-pocket costs as a measure of societal costs does not accurately indicate who bears the final costs. For example, trained and certified personnel may be able to command higher wages, thus shifting their training costs onto property owners. The question of who ultimately bears the cost is addressed in Chapter 9.

In estimating the costs resulting from new work practice standards, the basic elements are:

- the number of lead-based paint events (e.g., inspections, lead hazard screens, risk assessments, abatements), both pre- and post-Title IV, and

- the incremental costs of the EPA work practice standards, over and above the current industry practices for lead-based paint activities. Current costs include the costs imposed by the OSHA construction industry regulations, which recently took effect.

In estimating the costs resulting from new training requirements, the basic elements are:

- The number of personnel to be trained in each discipline, based on the number of lead-based paint events, and

- the per student cost of training for each discipline.

The third cost category covers the establishment and operation of the state and Indian tribe administration and enforcement systems. These costs will not be a simple function of the number of people or courses in the system because there are substantial fixed costs which are largely independent of the size of the system. Title IV encourages states to apply for the authority to administer and enforce the regulations by stipulating that EPA will develop a model state program. Costs were estimated for a sample of states and extrapolated to all other states. In cases where states do not run the programs, EPA will have the responsibility for administering and enforcing the program. EPA costs will be approximately the same as the estimates for state costs. In some cases, state costs may be lower than EPA costs because states are able to make use of existing certification and accreditation programs and procedures (e.g., asbestos programs).

5.2 Incremental Unit Costs

The costs of TSCA §402(a) include the incremental costs of the work practice standards and training requirements. These costs are a function of the number of units or individuals affected, and the per unit incremental costs due to the standards in the regulation and per person training costs, as provided in this section.

Unit cost data are drawn from a variety of sources. Estimates of the incremental costs of performing lead-based paint activities due to meeting the work practice standards are based on information provided by industry representatives and from other studies. Training cost data are developed from several sources. Tuition cost data were provided by training providers, including: RLTCs, private-sector and industry-sponsored training providers. Since lead-based paint training will be very similar to asbestos training, data from the Regulatory Impact Analysis for the Asbestos Model Accreditation Program (USEPA, 1993b) were also used. Data for the program administration costs were provided by several states that are establishing or revising their state programs in anticipation of this rule.

5.2.1 Incremental Costs Resulting From Title IV Work Practice Standards

Several of the work practice standards in §402(a) of TSCA will have cost implications for the lead-based paint inspection and abatement industry. The data used in this section are derived from industry contacts and other industry information sources, as well as other lead-based paint analyses prepared by Abt Associates for EPA (AAI, 1994). Standards that are already practiced by the industry are not considered incremental and thus their costs are not included in this analysis. Estimates for the incremental costs associated with §402(a) can be found in Exhibit 5.1.

Inspection While this regulation does not require that inspections be performed, it does specify what activities (e.g., paint samples, written analysis report) constitute an inspection. It also specifies that an inspection must be performed by a certified inspector or risk assessor. The incremental inspection cost due to this rule would be composed of the additional hours of inspector's or risk assessor's time (at his/her hourly rate) plus the cost of any additional samples to be tested. Based on data from the Minnesota Department of Health, inspector wages are $41 per hour. Comparing the requirements of this rule to the industry practice for an inspection, however, the analysis determined that there would be

Exhibit 5.1: Incremental Costs of §402(a) Work Practice Standards*				
Standard	**Hours/ Unit****	**Per Unit Costs**	**Incremental Costs**	**Total Incremental Costs**
5.1.a: Incremental Costs of §402(a) Work Practice Standards: Target Housing				
Inspection	0	$41	$0	$0
*Lead Hazard Screen****				$95
- Single Family				
- labor	1	$41	$41	
- dust sample	2	$23	$45	
- Multi-family				
- labor	2	$41	$82	
- dust sample	4	$23	$90	
*Risk Assessment****				$181
Activities included in lead hazard screen			$95	
- Single Family				
- labor	1	$41	$41	
- soil sample	2	$23	$45	
- Multi-family				
- labor	1	$41	$41	
- soil sample	2	$23	$45	
Weighted Average Lead Hazard Screen/Risk Assessment******				$116
Abatement (both permanent and enclosure/encapsulation)				$249
- Pre-abatement notification (10+ units)	0.5	$5	$3	
- Occupant Protection Plan	1	$51	$51	
- Post Abatement Clearance				
- Labor	2	$41	$82	
- Dust Sampling (Int)	5	$23	$113	
Soil Abatement				$179
- Occupant Protection Plan	1	$51	$41	
- Post Abatement Clearance				
- Labor (Post Abatement Report)	2	$41	$82	
- Dust/Soil Sampling	2	$23	$45	
Exterior Abatement				$48
- Pre-Abatement Notification	0.5	$51	$26	
- Post Abatement Clearance				
- Sample (dripline)	1	$23	$23	

* A comparison of the requirements of the rule, current practices, and the resulting additional activities that form the basis for these incremental costs is presented in Appendix 5-D.
** Number of hours includes direct labor, as well as recordkeeping and reporting labor hours.
*** The total incremental costs are a weighted average of the costs for single-family and multi-family housing. The costs for single-family target housing (about 90 percent) and multi-family (about 10 percent) are combined to yield a weighted average incremental cost of $95 per Lead Hazard Screen and $181 per risk assessment.
**** A weighted average of lead hazard screen and risk assessment costs is calculated, reflecting the assumption that some units will receive a risk assessment (about 24 percent) at an incremental cost of $181 and the rest (about 76 percent) will receive a lead hazard screen at an incremental cost of $95.

Exhibit 5.1: Incremental Costs of §402(a) Work Practice Standards* (continued)				
Standard	**Hours/ Unit****	**Per Unit Costs**	**Incremental Costs**	**Total Incremental Costs**
5.1.b.: Incremental Costs of §402(a) Work Practice Standards: Child-Occupied Facilities				
Inspection	0	$41	$0	$0
Lead Hazard Screen				$173
- labor	2	$41	$82	
- dust sample	4	$23	$90	
Risk Assessment				$259
Activities included in lead hazard screen			$173	
- labor	1	$41	$41	
- soil sample	2	$23	$45	
Weighted Average Lead Hazard Screen/Risk Assessment***				$193
Abatement				$544
- Pre-abatement notification (all units)	1	$51	$51	
- Occupant Protection Plan	2	$51	$103	
- Post Abatement Clearance				
- Labor	4	$41	$164	
- Dust Sampling (Int)	10	$23	$226	
Soil Abatement				$357
- Occupant Protection Plan	2	$51	$102	
- Post Abatement Clearance				
- Labor (Post Abatement Report)	4	$41	$164	
- Dust/Soil Sampling	4	$23	$90	
Exterior Abatement				$97
- Pre-Abatement Notification	1	$51	$51	
- Post Abatement Clearance				
- Sample (dripline)	2	$23	$45	

* A comparison of the requirements of the rule, current practices, and the resulting additional activities that form the basis for these incremental costs is presented in Appendix 5-D.
** Number of hours includes direct labor, as well as recordkeeping and reporting labor hours.
*** A weighted average of lead hazard screens and risk assessments is calculated, reflecting the assumption that some COFs will receive a risk assessment (about 24 percent) at an incremental cost of $181 and the rest (about 76 percent) will receive a lead hazard screen at an incremental cost of $95.

neither additional hours nor samples required by this rule. (Some of what is currently done during an inspection goes beyond what this rule defines as an inspection and will now be done in the lead hazard screen and/or risk assessment, described below.) As a result, there is no incremental cost associated with inspections under this rule for either target housing or child-occupied facilities.

Lead Hazard Screen and Risk Assessment Under this rule there are three approaches to identifying lead-based paint and the resulting hazards. These three approaches (inspections, lead hazard screens, and risk assessments) may be used either singularly or in combination, depending on the particular circumstances and the preferences of the property owner. Lead hazard screens, to be performed by certified risk assessors, entail a visual inspection of the property for condition of paint and limited tests of dust and paint samples. A lead hazard screen identifies the absence of lead hazards. In addition to the paint samples required for an inspection (for which there are no incremental costs), a lead hazard screen necessitates the testing of approximately two dust samples, requiring approximately one hour of time for the risk assessor for single family units, and four dust samples and two hours of labor for multi-family units. Estimated costs of lead testing is $23 per sample for the Atomic Absorption Analysis, which is typically used to measure lead concentrations in lead-based paint, lead-dust, and lead-soil (Minnesota Department of Health, 1993). The average cost (weighted to represent the expected mix of single and multi-family units) for lead hazard screens is $95.

If the unit is in bad condition, then a risk assessment is recommended instead of the lead hazard screen. The analysis assumes that, based on the guidance risk assessors receive during training, they will analyze all the paint and dust samples assumed under inspections and lead hazard screens. In addition, two soil samples must be taken. Therefore, the incremental requirements, in addition to the lead hazard screen, would be testing two samples and one hour of the risk assessor's time. The average risk assessment cost (weighted to represent the expected mix of single and multi-family units) is $181.

To account for the fact that some housing units will have lead hazard screens and some will have risk assessments, the analysis uses a weighted average of the two incremental costs. In calculating the weighted average, it was assumed that all housing units with lead-based paint had one or the other. The weights equal the percentage of target housing units with lead-based paint in good condition (suitable for lead hazard screens (76.1%)) and the percentage of target housing units with lead-based paint in deteriorated condition (suitable for risk assessments (23.9%)). The total weighted average cost is about $116 (See Exhibit 5.1).

The analysis assumes that each child-occupied facility (COF) found to have lead-based paint (via an inspection) will receive either a lead-hazard screen or a risk assessment to verify the presence of lead hazards. A similar weighted average of lead hazard screens and risk assessments is calculated for COFs. The sampling procedure for child-occupied facilities is assumed to be the same as for multi-family houses. As shown in Exhibit 5.1, this results in an estimated incremental cost of $173 for lead hazard screens, $259 for risk assessments, and a weighted average of $193. While it is likely that some child-occupied facilities will proceed with abatements on the basis of the inspection results, data on which to base an alternative estimate are not available at this time. Since concerns about liability are very high where large numbers of children are involved, the analysis assumes all inspections that find lead-based paint will lead to a lead hazard screen or risk assessment. To the extent that fewer are performed, total incremental costs are overestimated.

Abatement Abatement costs for both target housing and child-occupied facilities will increase due to pre-abatement plans and post-abatement plans. In addition, pre-abatement notifications are recommended for all child-occupied facilities and for target housing abatements in buildings with ten or more units.

For target housing, the occupant protection plan is estimated to take one hour to prepare and is often prepared by a project designer, with an hourly rate of $51. The post-abatement clearance work is performed by the risk assessor and is estimated to take two hours and require five dust samples. In the case of child-occupied facilities, the analysis doubles the number of samples as well as the amount of time required for the preparation of the occupant protection plan and performance of the post-abatement clearance. This assumption is based upon discussions with industry and the data presented in the OSHA analysis indicating that child-occupied facilities, on average, require resources equivalent to the two target housing abatement jobs.

All child-occupied facility abatement jobs are required to submit a pre-abatement notification. This is estimated to require one hour at an hourly rate of $51. Since residential abatements in buildings with ten units or more are required to file pre-abatement notifications, the unit cost was dropped from $51 to $5 to reflect the fact that only about 10 percent of target housing abatements are affected by this requirement (see Exhibit 5.1).

In addition to requiring pre-abatement and post-abatement plans, and pre-abatement notifications in some cases, the §402(a) regulations restrict the use of certain work practices. Based on discussions with industry contacts, except for dry scraping, the restricted practices listed in the rule are rarely used in target housing or child-occupied facility abatements. According to these contacts, dry scraping is used in about 25 percent of abatements. The substitution of other methods, such as wet scraping, would increase costs in those cases by about 2 percent, or 0.2 percent on average. The rule, however, only restricts and does not ban the use of dry scraping. For these reasons, the analysis assumes that there are no incremental costs due to the restricted practices.

The analysis assumes that the per-abatement incremental costs are the same for all abatement approaches both permanent and relatively permanent. Over the life of the unit, however, total incremental costs will be greater for enclosure/encapsulation than for permanent abatements, because the relatively permanent approaches will need to be repeated every 20 years. In addition to repeating the enclosure and/or encapsulation every 20 years, these units will need a thorough dust cleaning in the eighth and sixteenth years after the enclosure and/or encapsulation occurs. These dust cleanings do not require any special training, nor are performance standards established for them. Thus, they do not add to the incremental cost of this rule.

Soil Abatement The incremental soil abatement costs are the result of requirements to prepare an occupant protection plan and perform post-abatement clearance. A supervisor prepares the plan, which is estimated to require one hour for target housing and two hours for child-occupied facilities. The post-abatement clearance is performed by a risk assessor and is estimated to require two hours of time and the testing of two soil samples for target housing and four hours of time and the testing of four soil samples for child-occupied facilities. Together, these requirements cost an estimated $179 and $357. It is left to the judgment of the risk assessor as to how much soil is removed and replaced. The current common practice is to replace soil to a depth of 2½ inches. The analysis assumes that this will be sufficient. A sensitivity analysis, presented in Chapter 7, estimates the additional incremental cost if 6 inches of soil were replaced.

5.2.2 Incremental Costs Resulting from Title IV Training Requirements

Because very few lead training programs have fully developed their curriculum or determined the supply and demand for their services, there is no single source of information on the anticipated cost for lead training mandated under Title X of the Housing and Community Development Act of 1992. Therefore, it is necessary to collect and analyze information from several sources. The two primary sources of information used to determine preliminary cost numbers were: (1) the Asbestos Model Accreditation Plan (MAP) Regulatory Impact Analysis (USEPA, 1993b) and (2) information provided by the Regional Lead Training Centers (RLTCs) and private training providers.

During conversations with RLTC and state lead program staffs, several people indicated that they expected the clientele for lead training to be similar to the asbestos training clientele. Since the nature of the training is similar, the cost of asbestos and lead training is likely to be comparable. The Asbestos MAP, similar to the lead rule, defined several disciplines of work. Both rules require specific training for each discipline. While the structure of the asbestos and lead training courses vary in terms of: (1) the number of days required to complete the course and (2) the proportion of hands-on versus classroom time, the five lead-based paint abatement disciplines could be "matched" to asbestos abatement disciplines.

Since the course requirements for asbestos training are somewhat different from those for lead-based paint training, costs were calculated for: (1) additional training hours (classroom or hands-on) and (2) substitution of hands-on for classroom hours. Using information in the Asbestos RIA and information provided by the RLTCs, the cost for additional hours were determined and are reported in Exhibit 5.2.

Each additional hour adds to the cost of training and the average increase goes up as the sophistication of the course increases. In addition, hands-on training is more expensive

Exhibit 5.2: Per Unit Training Costs		
	Cost for Each Additional Training Hour	**Additional Cost to Substitute Hands-on for Classroom Training**
Inspector Risk Assessor* Project Designer*	12.84/hour 102.72/day	12.84/hour 102.72/day
Supervisor**	10.27/hour 82.16/day	10.27/hour 82.16/day
Worker**	8.22/hour 65.76/day	8.22/hour 65.76/day
* Tuition cost estimate based on information provided by Georgia-Tech and Western RLTC. ** Based on information provided in the Asbestos Model Accreditation Plan (MAP) Regulatory Impact Analysis.		

than classroom training because the pupil to instructor ratio is usually smaller and more expensive equipment is needed.

Using the cost per hour in Exhibit 5.2, asbestos training requirements were compared to lead training requirements to estimate the tuition costs for lead-based paint training. The results of the comparison are presented in Exhibit 5.3. This exhibit outlines the training requirements for the five lead disciplines and compares them to the asbestos training requirements. This provides one source for estimating lead training tuition costs. Asbestos training courses ranged from 3 days with no hands-on training to 5 days with no hands-on training, and from $357 to $532. The variation across lead-based paint training courses was greater, ranging from 2 days with 1 day of hands-on training to 5 days with two days of hands-on training (risk assessors take the inspector course plus 2 days with 1 day of hands on), and from $309 to $641.

The second source of information used to determine lead training tuition costs was information provided by the RLTCs. Information from 11 RLTC consortium members regarding the tuition they are charging is summarized in the Exhibit 5.4.

Exhibit 5.3: Comparison of Lead Abatement and Asbestos Abatement Training Requirements					
	Asbestos Training (MAP)			Lead Training	
Asbestos Discipline	**Course Requirements**	**Tuition Cost* ($)**	**Lead Discipline Equivalent**	**Course Requirements**	**Tuition Cost** ($)**
Inspector	3 days; 1/2 day hands-on	383	Inspector	3 days; 1 day hands-on	434
Management Planner	5 days; no hands-on	441	Risk Assessor	5 days, 2 days hands-on	641
Project Planner	3 days; no hands-on	532	Project Designer	5 days; 1 day hands-on	605
Contractor/ Supervisor	4 days; 3/4 day hands-on	485	Supervisor	4 days; 1 day hands-on	520
Worker	3 days; 3/4 day hands-on	357	Worker	2 days; 1 day hands-on	309

* As reported in Asbestos Model Accreditation Plan RIA.
** Estimated based on asbestos training costs.

Many of these RLTCs have been offering courses for several years. The current course curricula are based on the initial training requirements set by EPA. For TSCA §402(a), EPA is changing some of the training requirements. The costs reported on Exhibit 5.4 were provided by the RLTCs, adjusted to meet EPA's new training guidelines using the costs determined in Exhibit 5.2.

The cost of tuition is only one component of the total cost of training. Other costs include: lost wages, incidentals (per diem and travel), and the fee for the third-party exam. This study uses the non-tuition costs per day developed for the RIA of the Asbestos MAP.

While in training, the individual is unable to perform his/her usual job and this productivity is lost to society. This is true whether or not the individual is being paid to attend the training. For purposes of this analysis, the individual's wage rate is used as a measure of his/her productivity. Therefore, an additional cost of training is the number of hours spent in training multiplied by the wage rate, as shown in the following calculation:

$$(\#\ \textit{of days of training}) \times (\textit{wages per hour} \times 8) = \textit{Total lost wages}$$

The Bureau of Labor statistics reports median wages by SIC codes. The five lead disciplines were matched with the SIC codes to determine wage rates (see Exhibit 5.5). (U.S. Department of Labor, 1995a, 1995b.)

Exhibit 5.4: Regional Lead Training Center Tuition Costs*					
Training Provider	**Inspector**	**Risk Assessor**	**Project Planner**	**Supervisor**	**Worker**
U. of California-San Diego	$565	$668	$668	$668	$565
U. of Cincinnati	514			770	
Cleveland DEH				714	
U. of Minnesota	514			770	770
U. of Illinois	611			683	
U. of California-Davis	508			611	436
U. of Oregon	514				
UMass-Amherst	462			462	385
U. of Maryland	462	652		642	
Georgia-Tech	688	688	616	791	
U. of Kansas	595			769	
Mean	543	669	642	689	539
Mean adjusted for EPA required days	512	738	745	663	408
* Adjusted to reflect 1994 dollars.					

Based on the similarities between lead-based paint and asbestos abatement training and the large number of asbestos training sites, the estimation of incidental expenditures assumed that trainees would not need to travel long distances for training, would travel to and from their homes each day, and would only need to buy lunch during the training. The incidental cost includes a per diem cost of $7.50 (for lunch) and travel cost of $6.88 (25 miles/day @ $.275/per mile.) The incidental cost was calculated as follows:

$$(\#\ \textit{of days for training}) \times (\textit{per diem} + \textit{travel}) = \textit{incidental cost}$$

Exhibit 5.6 calculates total non-tuition costs per person, including the third party exam fee of $70 for inspectors, risk assessors, and supervisors. These costs range from $228 for abatement worker trainees to $1,011 for risk assessor trainees. Exhibit 5.7 determines the total training cost per person based on a high and low estimate for tuition costs. For these calculations, the average RLTC tuition costs (Exhibit 5.4) were used as the

Exhibit 5.5: Wage Rates*			
Discipline	**Bureau of Labor Statistics Category**	**Wages ($ per hour)**	**Wages ($ per day)**
Inspector	Management-related occupations, Construction inspector	20.22	161.76
Risk Assessor	Management-related occupations, Inspectors and compliance officers (except Construction)	21.68	173.44
Project Designer	Professional specialty, Architects	23.02	184.16
Supervisor	Construction Trades, Supervisors	20.25	162.00
Worker	Construction Trades, Painters, construction and maintenance	12.39	99.12

* All wage rates include 30 percent for fringe benefits. See "Economic Analysis of OSHA's Interim Final Standard for Lead in Construction," OSHA 1993.

Source: U.S. Department of Labor, Bureau of Labor Statistics, "Employment and Earnings," January and March 1994.

high estimate, and the tuition costs based on asbestos training were used as the low estimate. Total training costs per person are lowest for abatement workers ($636) and highest for risk assessors ($1,749).

Exhibit 5.6: Total Non-Tuition Cost						
	Days of Training Required by EPA	**Wages per day**	**Total wages lost**	**Incidentals**	**Third Party Exam Fee**	**Total Non-Tuition Cost**
Target Housing and Child-Occupied Facilities						
Inspector	3.0	$162	$485	$44	$70	$600
Risk Assessor	5.0	173	867	74	70	1,011
Project Designer	5.0	184	921	74	0	995
Supervisor	4.0	162	648	59	70	777
Worker	2.0	99	198	30	0	228

Source: See text for discussion.

Exhibit 5.7: Total Training Costs Per Person					
	Total Non-Tuition Cost	Tuition Rates		Total Training Cost	
		Low*	High**	Low	High
Target Housing and Child-Occupied Facilities					
Inspector	$600	$434	$512	$1,034	$1,112
Risk Assessor	1,011	641	738	1,652	1,749
Project Designer	995	605	745	1,600	1,739
Supervisor	777	520	663	1,297	1,440
Worker	228	309	408	537	636

* Estimated using Asbestos costs.
** Estimated using average RLTC costs.

Refresher Training Title IV requires that individuals take a refresher course for their disciplines every three years. Inspectors, risk assessors, supervisors, and workers are required to complete a one-day refresher course. Project designers must complete a half-day course. The average tuition charged ($113) for refresher courses does not vary across disciplines.[1] The only cost that varies, therefore, is the lost wages for each discipline. The incidental costs are calculated in the same way as for initial training. Refresher training costs vary from $212 for project designers to $301 for risk assessors (see Exhibit 5.8).

Exhibit 5.8: Total Refresher Training Costs Per Person						
	Number of Days	Total Lost Wages	Inci-dentals	Total Non-Tuition Costs	Average Tuition Rate *	Total Refresher Training Cost**
Inspector	1.00	$162	$15	$177	$113	$289
Risk Assessor	1.00	173	15	188	113	301
Project Designer	0.50	92	7	99	113	212
Supervisor	1.00	162	15	177	113	289
Worker	1.00	99	15	114	113	226

* Based on costs provided by four RLTC and private training providers.

** First year refresher course cost for Inspectors, Risk Assessors, and Supervisors being grandfathered include an additional $70 national certification exam fee.

[1] Based on information provided from four training providers. This may overestimate the tuition for the Project/Designer course which is shorter than the others. Any overestimate will be a very small part of the total costs of the rule.

5.3 Total Costs of Standards and Training

Using the unit incremental costs estimated in Section 5.2 and the levels of activity estimated in Chapter 4, the total costs of the work practice standards and training requirements are estimated. The following sections present these estimates for the first and second effective years of the regulation and the present value for 50 years of the regulation.

5.3.1 Total Incremental Costs of Work Practice Standards

The incremental costs of work practice standards, per activity and structure type, and the total number of eligible units for each structure type were estimated in previous sections. In order to calculate the total incremental costs of work practice standards for each structure type, incremental unit costs are multiplied by the total number of activities for that structure type. Since the total incremental cost impact of TSCA §402(a) work practice standards will not be fully realized until sometime in the future, costs are discounted and summed over a 49-year period.[2]

Methodology The estimated costs of the work practice standards rely on several calculations presented in this report. As described earlier in this chapter, the additional activities required by the rule were identified by comparing the requirements of the rule to current work practices as inferred from information from industry.

The number of structures covered by an activity varies according to structure type and procedure. While all target housing units and child-occupied facilities built before 1978 are potential candidates for inspections and/or lead hazard screens to determine the presence of lead, abatements will occur in a much smaller group of units because they will not occur unless lead-based paint in need of an abatement has been found.

While the analysis assumes that abatements in housing units can be either permanent or enclosures/encapsulation, it assumes that all abatements in child-occupied facilities are permanent. Given the larger size, and frequently more complex construction, of a child-occupied facility their lead activities require more time and labor then activities in target housing. Based on discussions with the industry and the data presented in the OSHA analysis, child-occupied facilities, on average, require resources equivalent to two target housing abatement jobs to eliminate the lead-based paint hazard (as reflected in Exhibit 5.1).

Using the unit cost estimates developed earlier in this chapter, a 50-year stream of costs is estimated. Future costs are discounted to provide an estimate of the present value of these costs. Costs are calculated for 50 years for several reasons. Given the large number of units with lead-based paint, it will take many years to eliminate all problems. Even after

[2]The rule requires implementation of the work practice standards one year after implementation of the training and certification requirements. Therefore, 50 years of the rule includes zero work practice standards costs in the first year the rule is effective and positive work practice standards costs in the following 49 years.

50 years, over half the units with lead-based paint will not have been inspected nor had a lead hazard screen or risk assessment. Therefore, at the activity rates used in the analysis, the program will continue beyond the 50 years. However, after 50 years the value of costs becomes negligible due to the effects of discounting.

Discounting Since the benefits resulting from the proposed regulation will not occur simultaneously with the costs, it is necessary to discount the future streams of costs and benefits before comparing them. The time horizon over which costs and benefits are discounted in this analysis is 50 years. Two discount rates were used, 3 percent and 7 percent.

There is considerable debate in the economics discipline whether to use the social rate of time preference or the rate of return on investment when discounting. According to recent literature, the rates are quite similar so choosing one or the other will not make much difference in the magnitude of the present value estimate. The debate between using a rate of return on investment capital and the consumption rate of return focuses on whether investment or consumption is being displaced. Some discounting theory emphasizes that one dollar diverted from productive investment reduces the stream of production created by that marginal investment, while a dollar diverted from consumption would only substitute one type of consumption for another. This diverted capital argument is the basis of the "shadow price of capital" approach to discounting, which treats displaced investment as "costing" more than displaced consumption. The practical difficulty in implementing this approach is to identify which costs are diverted investments, and which are diverted consumption. Various pragmatic approaches to solving this dilemma have been proposed and used by the EPA and other government agencies for regulatory analysis, including the "two-staged" discounting approach (Kolb and Scheraga, 1990), or a single "blended rate" somewhere between the rate of investment return and the consumption return.

Recent developments in the economic literature have raised serious questions about the extent to which capital is actually "displaced" today. The displaced capital theory maintains that because regulation diverts funds from alternative investments, some investment opportunities are not undertaken. The pool of available capital is assumed to be fixed, forcing some investment to be foregone when capital is diverted. While the pool of available capital is relatively fixed (at least in the short run) in a closed economy, in an open economy capital can flow in from other countries. The increased demand for investment capital in the United States (created in part to finance the federal deficit) has attracted large amounts of capital into the country, and many economists feel this has significantly reduced the pressure that federal borrowing has had on real interest rates. While the supply of capital is not perfectly elastic, neither is it perfectly inelastic. An elastic supply of capital reduces the difference between investment rates of return and consumer rates of return.

Estimates of real rates of return on investment are lower than many people believe. The real rate of return on United States government bonds has been near zero percent for most of this century, while the annual return on a broad portfolio of stocks has averaged near

4 percent. In general, stocks have done better since 1980 (averaging 4.26 percent) than in the other periods this century, but the rate of return may return to historic norms in the future (Freeman, 1993). Thus, the real rates of return on investment opportunities range from near zero to 4 percent.

The issues involving the appropriate discount rates and procedures are complex, and are not likely to be resolved soon. Much of the recent economic literature summarizing the discounting debate concludes that discount rates reflecting either the social rate of time preference or the rate of return on investments are the appropriate discount rates to use, and also concludes that there is not much difference between the rates. For example, Moore and Viscusi (1990) find no evidence that the rate of time preference for environmental-related health effects differs from financial rates of return and cite evidence that a 2 percent rate is appropriate. Lind (1990) recommends a range of one to 3 percent, and Freeman (1993) recommends 2 to 3 percent.

In this analysis, best practice suggests that both benefits and costs should be measured as consumption foregone and thus the social rate of time preference has been used for discounting, although what the rate is called is a moot point if Moore and Viscusi's findings are correct. The reasoning for basing the discount rate on foregone consumption is that the benefits of the rule (e.g., avoidance of an IQ decrement) will provide the beneficiary with a higher income and therefore greater consumption potential. For costs the reasoning for basing the discount rate on foregone consumption is the manner in which the funds spent for rule compliance would otherwise be used. Some of the funds will come from consumers directly when they purchase inspections and abatements. Other funds will come from consumers, but indirectly, in the form of increased prices. Capital expenditures that will result from the rule by providers of services (both training and inspection risk assessment/abatement) will be small. It is likely that the annualization of these capital costs will be incorporated into their prices and passed on to the consumer. Therefore, the funds needed for compliance with the rule, would have gone toward consumption rather than investment.

Based on the information presented above, a 3 percent discount rate has been adopted as the most appropriate rate for use in this analysis. It is used in Chapters 5, 6, and 8 for the estimation of the present value of costs and benefits. A 7 percent rate is often used for government regulations, and to facilitate comparison among rules the results using 7 percent are presented as a sensitivity analysis in Chapter 7.

Total Discounted Incremental Costs Due to Work Practice Standards The total incremental costs for work practice standards is the sum of the incremental costs for each TSCA §402(a) requirement. Exhibit 5.9 presents the incremental costs associated with TSCA §402(a) work practice standards. In the first year of implementation, there are zero incremental costs, since this part of the rule is not required until the second year. In the second year of rule implementation, the cost is about $20 million. Target housing constitutes the largest part of the costs, with abatements making up 62 percent and target housing risk assessments/lead hazard screens making up another 35 percent.

Exhibit 5.9: Discounted Incremental Cost of §402(a) Work Practice Standards			
	1st year rule effective*	**2nd year rule effective***	**50-Year Standards Cost**
Standard	**3% discount rate**	**3% discount rate**	**3% discount rate**
Inspection in Target Housing	$0	$0	$0
Inspection in Child-Occupied Facilities	$0	$0	$0
Risk Assessment/Lead Hazard Screen in Target Housing	$0	$6,940,165	$223,651,244
Risk Assessment in Child-Occupied Facilities	$0	$88,390	$2,321,702
Abatement in Target Housing	$0	$12,352,838	$398,078,103
Abatement in Child-Occupied Facilities	$0	$247,805	$6,020,618
Soil Abatement — Target Housing	$0	$275,202	$7,228,658
Soil Abatement — Child-Occupied Facilities	$0	$1,066	$27,996
Total	$0	$19,905,465	$637,328,321

* The §402(a) regulations do not become effective until two years after promulgation. In the first year the regulations are effective, only the training requirements are in effect; the work practice standards came into effect in the second year. Thus, there are no work practice standards costs in the first year the rule is effective.

The analysis further projects the number of events in subsequent years. Since there is little experience on which to base these forecasts, the analysis assumes that the number of initial inspections, lead hazard screens and risk assessments, and abatements occurring during the first year, for each structure type, will continue to occur in subsequent years. Starting in year 20, there will be increased numbers of events as actions are repeated for some housing units. In other words, as the stock of eligible target housing units declines, the percentage undertaking lead-based activities increases.

Using a three percent discount rate, the present value over a 50-year period of Title IV work practice standards will be $637 million. Again, the highest incremental expenditure will be for target housing abatements and target housing risk assessments/lead hazard screens at 62 percent and 35 percent of total costs, respectively.

5.3.2 Total Training Costs

The previous sections have estimated the demand for trained personnel and the per person training costs. Since the analysis assumes a constant number of initial inspections, lead hazard screens and risk assessments, and abatements, the demand for trained personnel remains constant for the first 20 years. During this period, the number of people trained in each year varies due to grandfathering, refresher requirements, and attrition. The number of people trained per year increases when the recurrent identification and abatement activities start. In addition, the cost of training in future years must be discounted back to provide a present value estimate of future costs.

This section looks at the discounted cost of training for each discipline. Because the majority of the assumptions apply to all of the disciplines, the first section outlines the basic methodology used to calculate discounted costs.

Methodology As with the costs associated with the work practice standards, the estimates of the discounted cost of training rely on several calculations already presented in this report. The demand for trained personnel (in terms of number of personnel needed) in any given year is a function of the number of relevant events in that year. For example, the number of inspectors or risk assessors needed at any one time is a function of the number of inspections or lead hazard screens and risk assessments that are predicted to occur that year. The entire U.S. stock of target housing and child-occupied facilities constructed before 1978 may be subject to an inspection, lead hazard screen, or a risk assessment. While the eligible stock decreases over time as buildings are demolished, inspected, or abated, the analysis assumes that the same number of units receive an initial abatement every year.[3] In other words, the percentage of eligible units receiving a lead hazard evaluation or abatement increases over time. The assumption that rates increase over time is consistent with our assumption that demand will increase due to greater assurances of high quality work and greater concern about lead hazards. As described in Chapter 4, demolition rate was not included in the calculation of number of lead-based paint activities in child-occupied facilities. The number of inspections/risk assessment/abatements conducted in a year was determined in Chapter 4 of this report.

Number of Persons to be Trained: Initial and Refresher Training Several assumptions were made in order to convert the demand for trained personnel into an estimate of the total number of people trained in any given year. Under Title IV initial training courses are valid for three years and then a refresher course is required. Refresher courses are also valid for three years. The regulation includes a grandfathering clause where an individual can demonstrate that he has taken training "equivalent" to training outlined in this rule. Grandfathered individuals must take the one-day refresher course to become certified.

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[3]The analysis assumes that 0.5 percent of target housing is demolished every year (Abt Associates, 1994).

Due to grandfathering, some proportion of individuals will take the refresher course in the first year the rule is effective.

The number of people expected to take initial versus refresher courses in the first year is based on three assumptions. Since there is no complete count of the number of people trained by EPA-approved private training providers, the RLTC network training data were used to estimate the number of people trained per discipline. Training data were provided by the RLTCs for the period covering October 1992 to March 1995. This period represents approximately half of the total time from October 1992 until this rule becomes effective. Therefore, the training data were doubled in order to estimate the total number of people who will have received training and, therefore, will be grandfathered. Estimates for the number of project designers were not available from RLTCs; private training provider estimates were used to determine initial/refresher training requirements for this discipline. Information provided by RLTC representatives indicate that some people taking the supervisor and worker training will work on public, commercial, or steelstructures. However, since there is no way of knowing the percentage split, this analysis assumes that half will work on target housing and child-occupied facilities, and half will work on other structures. To account for training by non-RLTC providers, this number was doubled.

As described in Chapter 4, estimates of the number of persons needed in any given year are based on an assumed work load and an estimate of the number of activities that year. Inspections and risk assessors are assumed to perform, on average, 46 lead-based paint jobs per year. Project designers are assumed to average 23 lead-based paint jobs a year. Supervisors and workers average 20 lead-based paint jobs per year.

Based on these assumptions, all of the inspectors needed in the first year will already have training. Using EPA's definition of an inspection and the estimated number of inspectors expected to take refresher training in 1997, there will be a substantial oversupply of trained inspectors. It is likely that in the second year, many of these inspectors who meet the education requirements will take two additional days of training to become a risk assessor. This analysis assumes that the oversupply of inspectors in 1997 will shift to meet the increased demand for risk assessors under EPA's new definition.

Based on information from Massachusetts, the attrition rate each year was estimated to be 30 percent for target housing contractors and workers, and 25 percent for all other disciplines.[4] In other words, between 30 percent and one quarter of all active individuals will drop out in any given year. This is not the same as assuming that within three or four years of training the entire class will no longer be working; some people may continue working for many years while the attrition rate during the first year may be higher. The

[4]See Appendix 5.A for a further discussion of attrition rates.

total number of people to be trained is the difference between the number needed and the number continuing from the prior year.[5]

Every three years individuals still in the discipline are required to take a refresher course in their discipline. To understand how this was included in the analysis, the 1998 to 2001 period can be used as an example. In 2001, the people who received their initial (or refresher) training in 1998 are required to take refresher training. However, some proportion of the 1998 trainees will have dropped out of the system. The calculation to determine how many of the 1998 trainees will take refresher training in 2001 is the following:

(Proportion of those trained in 1998-2000 who were trained in 1998) × (Number continuing in 2001) = Number of individuals taking refresher training in 2001

Where: Number continuing in 2001 = 2/3 number working in 2000.

To summarize the above discussion, in each year the demand for trained personnel will be satisfied by a combination of persons trained within the past two years, persons taking refresher courses, and new entrants taking initial training. In the first year of the program, everyone will take either initial training or refresher training (those being grandfathered). The demand for certified personnel in the first year is presented in Exhibit 5.10. In cases where there are more than enough persons already trained, and eligible for grandfathering, no initial training is expected in the first year (e.g., inspectors and supervisors). Due to the excess supply, many inspectors are expected to upgrade to risk assessors in the second year. Since there is no logical upgrade for supervisors, the model simply assumes there will be an excess supply for the first few years, until the combined effects of attrition and low training rates brings supply into line with demand.

Total Discounted Training Cost The cost of training for each discipline was calculated in Section 5.2.2. For the calculations in this section, the high end tuition cost was used, resulting in maximum estimates of total tuition costs. Exhibit 5.11 summarizes the total cost per discipline in the first and second effective years and for the fifty-year period discounted at 3 percent. First-year and fifty-year training costs are highest for risk assessors, due to large demand for certified risk assessors. The total 50-year cost of training, discounted at 3 percent, ranges from $6,400 for child-occupied facilities soil abatement workers to $100

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[5]Discussions with abatement firms revealed a wide range of experience in terms of average length of time people stay in the industry, ranging from "one to two years" to "people never leave." One respondent said that in general, people in the lead abatement industry were less professionally committed than the personnel in similar industries such as asbestos abatement. Since these discussants provided such a wide range of answers, the Massachusetts data were used in the analysis. To the extent that attrition rates have been over-estimated in the analysis, training costs have also been over-estimated.

Exhibit 5.10: Demand for Initial and Refresher Training			
	Demand	**Trained in First Year**	
	First Year Rule Effective	**Initial**	**Refresher**
Target Housing			
Inspector	2,490	0	7,461
Risk Assessor	5,990	4,086	1,904
Project Designer	247	92	155
Supervisor	2,775	0	5,426
Worker	5,551	5,150	401
Child-Occupied Facilities			
Inspector	72	0	217
Risk Assessor	22	15	7
Project Designer	4	2	3
Supervisor	50	0	98
Worker	100	93	7
Target Housing - Soil			
Supervisor	132	132	0
Worker	265	265	0
Child-Occupied Facilities - Soil			
Supervisor	1	1	0
Worker	2	2	0

million for target housing risk assessors. Total costs for all disciplines, over 50 years, discounted at 3 percent, are $228 million.

Exhibit 5.11: Discounted Incremental Training Cost Summary by Discipline			
	1st year effective	2nd year effective	50-Year Training Cost
Discipline	3% discount rate	3% discount rate	3% discount rate
Target Housing			
Inspector	$2,525,016	$0	$28,270,367
Risk Assessor	$7,400,762	$4,296,582	$99,514,609
Project Designer	$182,473	$98,320	$3,865,453
Contractor	$1,837,589	$0	$47,138,862
Worker	$3,172,678	$946,574	$43,449,458
Target Housing — Soil Abatement			
Contractor	$179,820	$43,646	$1,557,375
Worker	$158,845	$38,555	$1,533,324
Child-Occupied Facilities			
Inspector	$73,497	$0	$657,899
Risk Assessor	$26,860	$8,698	$292,220
Project Designer	$3,287	$1,771	$55,202
Contractor	$33,106	$0	$579,247
Worker	$57,159	$17,053	$624,467
Child-Occupied Facilities — Soil Abatement			
Contractor	$823	$1,541	$12,592
Worker	$615	$149	$6,432
Total	$15,652,530	$5,452,889	$227,557,506

5.4 Title IV, Section 404: State Administration and Enforcement

Section 404 of TSCA authorizes the establishment of State programs to administer and enforce the other requirements of the Act. It also provides a schedule for EPA approval of State applications, and mandates that EPA develop a model program which can be adopted by States, Indian tribes, and Alaskan Native Villages seeking to administer and enforce a program under this title. As stated in the Act, the regulations should encourage States to seek program authorization and to use existing State or local government certification and accreditation procedures.

Since this is a new set of requirements, State programs are not currently in operation under EPA authority. As a result, there is little direct data available to use in estimating the costs of establishing and running a State program under Title IV. There are two sources of information, however, that can be used to generate estimates of program costs. One is a group of estimates provided by five States that are in the process of setting up programs for Title IV: Vermont, Rhode Island, Connecticut, Minnesota, and California. The second source is the previous analysis of the Asbestos Model Accreditation Plan.

While Title IV does not require that States establish programs to administer and enforce these requirements, it encourages this. Since there is no basis for projecting at this time how many States will enact programs to address lead-based paint and its associated hazards in target housing and child-occupied facilities, this analysis assumes that all States will develop complete plans. In cases where the State does not establish a program, the variable cost of EPA administration and enforcement would be comparable to the State costs estimated in this report. The one-time, start-up, fixed costs for EPA would be the same regardless of the number of programs that they must administer; the annual fixed costs would be incurred for each program.

5.4.1 Program Costs for States

To provide a basis for estimating State administration and enforcement program costs, several States were contacted for data. Five States were in the process of establishing State-level lead programs and were able to provide cost data. In each case, they provided the number of professional and clerical full-time equivalent employees, and salary costs including fringe and overhead. In addition, they provided estimates of other direct costs, such as equipment, supplies, and facilities costs. Cost data were provided for the first year (representing start-up costs), and the second year (representing ongoing costs) of their programs. For each State, the total costs each year were divided by an estimate of the number of housing units in the State with lead-based paint. Comparing States, the cost per housing unit declined as the number of lead-paint housing units increased, due to the existence of certain fixed costs. All fifty States, plus the District of Columbia, were ordered in terms of the number of housing units with lead-based paint, and divided into five groups. The State-level costs for each State were estimated by multiplying the State's number of housing units with lead-based paint by the relevant per unit cost. These State-level costs were summed to estimate the national costs. Sixteen States were not included in the summation because they currently have State level licensing and certification programs in place. The analysis assumes that any costs incurred by these sixteen States are a result of their State programs and not §§ 402(a) and 404. As shown in Exhibit 5.12, State program costs are estimated to be $15.2 million in the first year the rule is effective, and $9.5 million in the second and subsequent years. Total costs over 50 years, discounted at 3 percent, are estimated to be about $244 million. Calculations of State program costs are further described in Appendix 5.B.

Exhibit 5.12: Estimated State and Tribal Program Costs			
	1st year effective	2nd year effective	50-year Total Cost (3% discount rate)
State Program Costs	$15,216,824	$9,539,026	$243,640,121
Tribal Program Costs	$289,967	$209,967	$5,320,453
National Total (State and Tribal)	$15,506,790	$9,748,993	$248,960,574

5.4.2 Program Costs for Indian Tribes and Alaskan Native Villages

Section 404 also encourages Indian tribes and Alaskan Native Villages to obtain authorization for their own administration and enforcement programs. As described in Appendix 5.C, all indications from discussions with tribe and village association officials and EPA personnel, are that only a few tribes are likely to undertake this program. The most likely cases are in EPA Regions I and X. Based on these discussions, the analysis assumes that four tribes and/or Alaskan Village Associations will obtain authorization, and in each case their programs will be much smaller than even the smallest States. Based on the State data, a minimum-sized program was assumed for each tribe, consisting of one-half a professional FTE and one-fifth a clerical FTE, with $30,000 in other direct costs to set up the program and $10,000 in other direct costs each subsequent year. As presented in Exhibit 5.12, the total costs for four Indian tribes and/or Alaskan Native Villages are estimated to be about $290,000 in the first year and about $210,000 in each subsequent year.[6] Total costs over 50 years, discounted at 3 percent, are estimated to be about $5.3 million.

5.5 Summary of Regulatory Costs

The total estimated cost of §402(a) of TSCA are presented in Exhibit 5.13. The total first year costs are estimated to be approximately $31 million and $35 million in the second year. The discounted costs over 50 years (3 percent discount rate), are estimated to be $1,114 million. The largest component of the cost is the incremental cost of the work practice standards; 57 percent of the total cost. Twenty percent comprises training of new and existing lead professionals according to EPA standards. Twenty-two percent of the total cost is estimated to be incurred by State program administrations (including Indian tribes and Alaskan Native Villages).

[6] See Appendix 5.C for a further discussion of Indian Tribe and Alaskan Native Village Program Costs.

Exhibit 5.13: Estimate of the Total Incremental Cost of Sections 402 of TSCA				
Cost Category	**First Year Effective (millions)**	**Second Year Effective (millions)**	**Total Discounted Cost* (millions)**	**Percentage of Total Cost**
Training	$16	$5	$228	20%
Standards	$ 0	$20	$637	57%
State Program Administration	$16	$10	$249	22%
Total	$31	$35	$1,114	100%
* Costs discounted at 3 percent for 50 years.				

Appendix 5.A. Average Annual Attrition Rates: Lead-Based Paint Activity Personnel

The training costs calculated in this Regulatory Impact Analysis are a function, in part, of the number of people trained. The number of people trained in any given year is based on a comparison of the estimated demand and supply for personnel in each of the disciplines (e.g. inspector, risk assessor, worker), for each year of the analysis. The model assumes that enough people will be trained each year to bring that year's supply into equilibrium with that year's demand, for each discipline.

The supply of trained personnel in any given year is based on the number of people active in the previous year, minus those who have dropped out of the profession (attrition), plus the number of people trained that year. There are several reasons why people would leave the profession. They may drop out because they find more enjoyable, better paying and/or more regular work. Abatement work can be unpleasant to perform and frequently does not pay particularly well. This is especially true for abatement workers. In addition, the demand estimates used in this analysis are not based on the "minimum number" of people needed to perform the predicted number of activities, but are based on the numbers observed in Massachusetts, which has a well-developed abatement industry. A comparison of the number of people certified to the number of abatement jobs performed implies that, for many of the disciplines, the average person performs only a few jobs a year. Under these circumstances, some people may decide that the level of activity does not warrant staying in this industry. Two other factors may also result in attrition. First, the number of people in a particular discipline may decrease as people move to a more skilled discipline (e.g. inspectors becoming risk assessors). Additionally, a final component of attrition takes the form of retirements. While some people will choose to make a long term commitment to this industry, they will eventually retire.

Since licensing programs have been in effect in only a few places, and for relatively short periods of time, there are limited data on which to base an estimate of attrition rates. Some data are available on contractors for Massachusetts. As described in detail below, these data were used as the basis for estimating annual attrition rates for all disciplines. For several reasons (simplicity of use, structure of the model, and data limitations), the model uses a constant attrition rate across all cohorts within a discipline.[7] For any given cohort, however, the attrition rate may decline over time. In the first year or two after certification, there may be higher rates of attrition as those who decide that this work is not for them drop out. Personnel who are still active several years after their initial training are likely to stay in the profession for a very long time. In the model, however, the attrition rate is not applied to individual cohorts, but to the aggregate of all active personnel in each year, regardless of the distribution across cohorts.

[7] Here cohort refers to the group of persons who were all certified in a discipline in the same year. Each year, a new cohort is introduced to each discipline. As each cohort moves forward through time, it continues to shrink in size as people leave the profession, or move up to a more-skilled discipline (attrition).

The attrition rate for supervisors was calculated using Massachusetts lead abatement contractors licensing data. Of the labor categories used by Massachusetts, the category they call contractors are most representative of the EPA category called supervisors. The data on the number of contractors are:

Number licensed during four-year period (1989-1992):		1,100
Number still active in 1992:	535	
Number trained in 1989:		213
Number licensed during six-year period (1989-1994):		1,300
Number still active in 1994:	438	

Based on this data, we can conclude that 200 new contractors were trained and certified during the two-year period 1993-1994, or approximately 100 per year. During this same two-year period, the total number of active contractors dropped by 97. Using the following relationships to calculate the number of active contractors in each year, the implied attrition rate for supervisors is 29.3 percent per year.

1992: 535
1993: (535)(X) + 100 = Y
1994: (Y)(X) + 100 = 438

where: X = annual attrition rate = .293
Y = estimated number active in 1993 = 478

By using data from the fifth and sixth year of the Massachusetts program, the data includes a more representative mix of new and old members of the profession, than would be true if we used data for the first years of the program.

Since similar data are not available for workers, the analysis assumes that the supervisor attrition rate also applies to workers. For various reasons, the attrition rate among inspectors, risk assessors and project designers is likely to be somewhat lower than that for workers and contractors. These disciplines require a greater investment in terms of training and education. The analysis assumes, therefore, that individuals will not undertake the certification procedures unless they are reasonably sure that they will continue to find this a rewarding activity. Unfortunately, comparable data for any of these three disciplines are not available. To reflect the expectation that the rate will be lower, the model assumes a 25 percent annual attrition rate for inspectors, risk assessors and project designers.

Appendix 5.B. State Lead Program Costs - Estimation Methodology

To provide a basis for estimating State administration and enforcement program costs, several States were contacted for data. Five States were in the process of establishing State-level lead programs and were able to provide cost data: Vermont, Rhode Island, Minnesota, Connecticut and California. In each case, the State is establishing a program that conforms with the requirements presented in the proposal for this rule. Thus, these States present a reasonable estimate of State costs. The States provided the number of professional and clerical full-time equivalent employees, and salary costs including fringe and overhead. In addition, they provided estimates of other direct costs, such as equipment, supplies, and facility costs. Cost data were provided for the first year (representing start-up costs), and the second year (representing ongoing costs) of their programs. Cost data provided by individual States are summarized in Exhibit 5.B.1. For each State, the total costs each year were divided by an estimate of the number of housing units in the State with lead-based paint. Comparing States, the cost per housing unit declined as the number of lead-paint housing units increased, due to the existence of certain fixed costs. All fifty States, plus the District of Columbia, were ordered in terms of the number of housing units with lead-based paint, and divided into five groups. The State-level costs for each State were estimated by multiplying the State's number of housing units with lead-based paint by the relevant per unit cost. These State-level costs were summed to estimate the national costs. Sixteen States were not included in the summation because they currently have State level licensing and certification programs in place. The analysis assumes that any costs incurred by these sixteen States are a result of their State programs and not §§ 402(a) and 404. Exhibit 5.B.2 presents calculations of first and on-going State program costs.

Exhibit 5.B.1: State Lead Program Cost Estimates

			Startup Costs				
	Staff Cost	Indirect Costs	Equipment & Supplies	Other	Ongoing Costs	Year One Budget	Year Two Budget
Vermont	$82,176	$40,765	$40,850	$8,200	$9,750	$171,991	$132,691
Rhode Island	$157,013	$27,484	$79,676	$7,000	$11,180	$271,173	$195,677
Minnesota	$139,200	$19,720	$158,920	$14,000	$15,000	$331,840	$173,920
Connecticut	$175,013	$45,000	$72,000	-	$16,000	$476,823	$236,013
California	$613,937	-	$313,944	-	$281,944	$927,881	$895,881

Exhibit 5.B.2: State Lead Program Costs					
		Cost per Household			
State	**# Lead Households**	**1st year**	**2nd year**	**1st year Costs***	**2nd year Costs**
Delaware	30,381	$2.65	$2.04	$103,403	$62,031
District of Columbia	30,750	$2.65	$2.04	$104,380	$62,785
Wyoming	33,969	$2.65	$2.04	$112,899	$69,357
Montana	37,638	$2.65	$2.04	$122,609	$76,848
North Dakota	38,560	$2.65	$2.04	$125,049	$78,731
South Dakota	41,440	$2.65	$2.04	$132,671	$84,611
Hawaii	71,556	$2.65	$2.04	$212,373	$146,101
Idaho	72,561	$2.65	$2.04	$215,033	$148,153
West Virginia	84,747	$2.65	$2.04	$247,283	$173,034
Nevada	93,666	$2.65	$2.04	$270,887	$191,245
Nebraska	96,320	$2.65	$2.04	$277,911	$196,664
Utah	107,937	$2.28	$1.64	$268,558	$177,193
New Mexico	109,143	$2.28	$1.64	$271,302	$179,173
Arkansas	109,593	$2.28	$1.64	$272,326	$179,912
Mississippi	112,053	$2.28	$1.64	$277,922	$183,950
Oklahoma	148,338	$2.28	$1.64	$360,471	$243,517
Kansas	151,200	$2.28	$1.64	$366,982	$248,216
South Carolina	154,734	$2.28	$1.64	$375,022	$254,017
Kentucky	169,740	$2.28	$1.64	$409,161	$278,652
Iowa	170,240	$2.28	$1.64	$410,298	$279,472
Alabama	185,361	$2.28	$1.64	$444,699	$304,296
Maryland	215,127	$1.80	$0.94	$409,632	$202,637
Oregon	221,703	$1.80	$0.94	$421,451	$208,831
Tennessee	228,042	$1.80	$0.94	$432,843	$214,802
Colorado	257,682	$1.80	$0.94	$486,113	$242,721
Arizona	275,169	$1.80	$0.94	$517,541	$259,193
North Carolina	309,591	$1.80	$0.94	$579,405	$291,616

Exhibit 5.B.2: State Lead Program Costs					
		Cost per Household			
State	**# Lead Households**	**1st year**	**2nd year**	**1st year Costs***	**2nd year Costs**
Indiana	330,400	$1.26	$0.62	$438,855	$205,835
Washington	376,272	$1.26	$0.62	$496,591	$234,413
Michigan	547,040	$1.26	$0.62	$711,526	$340,799
Florida	631,605	$1.26	$0.62	$817,963	$393,482
Texas	746,733	$1.26	$0.62	$962,868	$465,205
New Jersey	860,860	$1.26	$0.62	$1,106,512	$536,305
Pennsylvania	1,384,768	$0.70	$0.68	$995,397	$938,862
New York	2,044,812	$0.70	$0.68	$1,458,886	$1,386,366
Totals:				$15,216,824	$9,539,026

*First year costs include $23,000 in legislative costs, estimated based upon the experience of Minnesota in authorizing their lead licensing and certification program.

Appendix 5.C. Cost Estimates for Indian Tribes and Alaskan Native Villages

Estimating the costs of TSCA §402 and §404 to Indian Tribes and Alaskan Native Villages required estimating the number of tribes and/or villages that would chose to establish an administration/enforcement program, and the typical costs for each. Necessary data were collected from several EPA staff and tribal representatives, as well as the Bureau of Indian Affairs' *Indian Service Population and Labor Force Estimates*. Contacts are listed in Exhibit 5.C.3.

Based on these discussions, the analysis estimates that four Indian tribal groups will initiate lead programs: two in New England, one in Alaska, and one other. Size estimates are presented in Exhibit 5.C.1. Due to the small size of the tribes, the analysis estimates that each program will need one half-time professional and 20 percent of a clerical worker's time, in addition to $30,000 for startup costs, and $10,000 for ongoing costs, both including transportation. These costs are estimated from State costs. Cost estimates are presented in Exhibit 5.C.2

Number of Tribes

Tribes likely to establish a program were identified after speaking with EPA staff and tribal representatives. The Chemicals Management Division of the EPA is responsible for distributing §404g grants which were meant to be used to start lead programs. According to the Division, the tribes most likely to run a lead program are in EPA Regions I and X. This is largely because lead is more prevalent in the northeast and northwest. While tribes from other regions received grants, most of them will use the money to assess lead hazards and perform other public health tasks.

According to EPA Region I, the Houlton Band of Maliseet Indians and the Narragansett Indians, with populations of 560 and 2,058 respectively, are likely to start up lead programs. The Micmacs also received grant money but will work with the Maliseet to develop a lead program. The Maliseets report that they are still in the initial stages of organizing a lead program.

EPA Region X stated that the Alaskan Native Villages are still in the very early stages of assessing lead hazards that they face. A spokesman for the Bristoll Bay Native Association said that while they would like to run a lead program, many of the villages under their jurisdiction have other environmental issues which they are likely to deal with first. It is possible, however, that at least one Alaskan Native Association will run a program, for example, the Central Council of Tlinket and Haida Indian Tribes of Alaska with an enrollment of about 21,000. In the population estimate, we treat the three Native Associations as a group although it is highly unlikely that they will initiate a program together.

The Rosebud Reservation of South Dakota, with a population of 13,050, was selected as a mid-sized tribe in an area with a housing population likely to have lead hazard. The Rosebuds received §404g grants to do lead work in both 1994 and 1995.

Exhibit 5.C.1. Tribes Likely to Run a Lead Program

Tribe	Number of Members	Number of Houses with Lead Hazard*
Houlton Band of Maliseets	560	82
Narragansett Tribe	2,058	302
Rosebud Agency	13,050	994
Alaskan Tribal Agencies	27,406	2,623

* The number of housing units in each tribe was derived by dividing the number of members by 2.1, to estimate the number of people per housing unit. A percentage of this number was then taken, depending on the percentage of housing units with lead hazard for that region. 30.8% of housing units have lead hazards in the Northeast, 20.1% in the West, and 16% in North Central.

Source: 1990 U.S. Department of Housing and Urban Development *National Survey of Lead Based Paint in Housing.*

Cost to Tribes

Before estimating costs to tribes, data were collected to estimate the costs associated with establishing and running an administration/enforcement program from five States: Vermont, Rhode Island, Minnesota, Connecticut, and California. These States reported estimates on the number of professional and clerical staff needed, the annual salaries for these positions including benefits and overhead, startup costs including equipment and supplies, and estimated ongoing costs.

Each of the tribes and/or Native Villages analyzed has a population that is far smaller than the smallest State. Based on estimates provided by States, however, there appears to be a minimum staffing level required to run the program. This analysis assumes that each program will need half a professional and 20 percent of a clerical worker’s time. The wage rates used are the average wage rates of the five States. In addition to staffing costs, this analysis assumes that $30,000 will be needed for startup and $10,000 for subsequent years. These estimates include the cost of a new computer and a vehicle in the first year, as well as supplies and travel costs in the first and subsequent years. Total costs for the four tribes/Native Villages is four times the estimated per tribe cost.

Exhibit 5.C.2. Cost Estimates for Tribes								
Staff Size and Salaries								
Prof.	**Annual Salary with Benefits and Overhead**	**Clerical**	**Annual Salary with Benefits and Overhead**	**Staff Cost**	**Startup Costs**	**Ongoing Costs**	**First Effective Year Budget**	**Subsequent Year Budget**
0.5	$68,227	0.2	$41,891	$42,492	$30,000	$10,000	$72,492	$52,492
Total Costs for Four Tribes							$289,967	$209,967

Exhibit 5.C.3. EPA and Tribal Contacts		
Name	**Agency**	**Phone**
Ken Bouser	EPA Region I	617 565-3286
Lyn Burger	EPA Chemicals Management Division	202 260-3454
Jim Burton	Houlton Band of Maliseet Indians	207 532-4273
Arthur Glass	EPA Region I	617 565-3841
Terri Hoefferle	Bristoll Bay Native Association	907 842-5257
Steve Oyama	Indian Health Services	301 443-1046
Marlene Relegski, Director	EPA American Indian Envr. Office	202 260-7284
Viccy Salizar	EPA Region X	206 553-1060
Jim Sappier	EPA Region I	617 565-9229
Rupert Schmidt	EPA Region X	206 553-2724
Tom Tillman, Chief	EPA Environmental Assistance Division	202 260-3790

Appendix 5.D: Basis for Estimating Incremental Performance Standards Costs

Activity	Requirements of the Rule	Current Practices	Additional Activities Required by Rule
Inspections	The objective of an inspection is to develop, and then report on, the existence of lead-based paint in a unit through a surface-by-surface investigation. The regulation does not provide detailed guidance on how to perform specific lead-based paint identification, rather the Agency includes performance-based requirements that refer to documented methodologies and adequate quality control procedures that are taught in accredited training courses.	Comparing the requirements of the rule to standard industry practice for an inspection, the analysis determined that no additional hours nor samples would be required by the rule. Some of what is currently done for an inspection goes beyond the rule's requirements for an inspection and will now be done in the lead hazard screen and/or risk assessment.	The analysis attributes no costs to the work practice standards required during the inspection of target housing and child-occupied facilities.
Lead Hazard Screens	A lead hazard screen requires a visual inspection of the property for condition of the paint, sampling of components with deteriorated paint, two composite dust samples, and the preparation of a report on the results of the screen. A lead hazard screen is intended to determine the absence of a lead-based paint hazard, rather than the presence and risks that such a hazard may pose to building occupants.	Currently, lead hazard screens are not commonly performed and several of the elements required under a lead hazard screen are considered to be new costs to society. The analysis assumes, however, that anyone who would have a lead hazard screen under this rule would have otherwise had an inspection in the absence of the Agency's proposed rule. Therefore, the identification of lead paint (i.e., paint sampling) would have been done.	The analysis assumes that, in addition to the inspection activities, a lead hazard screen will require roughly two composite dust samples and one hour of risk assessor time for single family units and four composite dust samples and two hours of time for multi-family units or child-occupied facilities. Because the analysis assumes that anyone who would have a lead hazard screen under this rule would have otherwise had an inspection, the costs associated with lead paint identification are not included in the incremental cost of performing a lead hazard screen.

Activity	Requirements of the Rule	Current Practices	Additional Activities Required by Rule
Risk Assessment	The objective of a risk assessment is to determine, and then report on the existence, nature, severity, and location of lead-based paint hazards through an on-site investigation. In addition to the requirements of a lead hazard screen, a risk assessment includes the collection and review of background information regarding the physical characteristics of the building and the occupant use patterns. A set of lead hazard control strategies must be provided to address all lead hazards identified as a result of the risk assessment, including a maintenance and monitoring schedule if encapsulation or enclosure are recommended.	Currently, risk assessments are not commonly performed. The analysis assumes, however, that anyone who would have a risk assessment performed under this rule would have otherwise had an inspection in the absence of the Agency's proposed rule. Therefore, the identification of lead paint (i.e., paint sampling) would have been done.	The analysis assumes that, in addition to the inspection activities, a risk assessment will require two composite dust samples, two soil samples, and two hours of risk assessor time for single-family units. A multi-family unit or child-occupied facility is assumed to require four composite dust samples, two soil samples, and three hours of risk assessor time. The analysis assumes that more time will be required than for a lead hazard screen because of the need to collect information on people living in the units, and the need to prepare a more comprehensive report. Because units that receive a risk assessment are assumed to have otherwise received an inspection, the costs associated with lead paint identification are not included in the incremental cost of conducting a risk assessment.

Activity	Requirements of the Rule	Current Practices	Additional Activities Required by Rule
Abatement	The Rule requires the preparation of a pre-abatement plan and post-abatement plan for both target housing and child-occupied facilities. In addition, pre-abatement notifications are recommended for all child-occupied facilities and for target housing abatements in buildings with two or more units. While the Rule prohibits the use of certain practices, it does not otherwise specify required procedures during the abatement.	Occupant protection plans, post-abatement clearance, and pre-abatement notifications are currently not required of the lead abatement industry and are, therefore, not assumed to be conducted. The prohibited practices, however, are rarely if ever used for residential or child-occupied facility abatements. Thus, there are no incremental costs associated with these prohibitions.	**Occupant Protection Plan**: The analysis assumes that the preparation of an occupant protection plan will require one hour of project planner time for target housing and two hours of time for child-occupied facilities. **Post-abatement Clearance**: The post-abatement plan and testing is assumed to require two hours of risk assessor time and five dust samples. In the case of child-occupied facilities, the burden is doubled: four hours of risk assessor time and ten dust samples. **Pre-abatement Notification**: The analysis assumes that one hour is required to conduct pre-abatement notification for both child-occupied facilities and target housing with two or more units. The burden associated with the preparation of a pre-abatement plan, pre-abatement notification, and post-abatement plan are considered to be new costs to industry and would therefore not have any existing costs deducted.

Activity	Requirements of the Rule	Current Practices	Additional Activities Required by Rule
Soil Abatement	The Rule requires the preparation of a pre-abatement plan and post-abatement plan when conducting a soil abatement for both target housing and child-occupied facilities.	Occupant protection plans and pre-abatement notifications are currently not required of the lead abatement industry and are, therefore, not assumed to be conducted. The Agency leaves it to the judgement of the risk assessor to determine how much soil is removed and replaced. Current practice is assumed to be 2 ½ inches of soil. The sensitivity analysis estimates the incremental cost if 6 inches of soil were replaced.	**Occupant Protection Plan**: The analysis assumes that one hour of project planner time is required to prepare an occupant protection plan for target housing and two hours of project planner time for child-occupied facilities. **Post-abatement Clearance**: Post-abatement clearance is performed by a risk assessor and is estimated to require two hours of time and the testing of two soil samples for target housing and two hours of time and the testing of four soil samples for child-occupied facilities.

6. BENEFITS OF THE REGULATION

The monetary benefits of §§402(a) and 404 consist of the value of the risk reductions brought about by using trained labor to perform inspections, risk assessments, and abatements in residential units and child-occupied facilities (COFs), by conducting all abatement-related activities implementing the work practice standards and meeting the post-abatement clearance requirements, and by avoiding costs for the abatements that do not need to be performed. The published case study literature reviewed in Chapter 3 suggests there can be considerable exposure and risk associated with improperly performed abatements, but that the use of proper techniques can substantially reduce the exposure and risk. The potential benefits of §§402(a) and 404 are decreased lead exposure, and hence decreased risk of adverse impacts of lead exposure, in the following categories:

- Decreased exposure to residents of houses during, and immediately following, abatement due to the occupancy protection plan and cleaning up lead contaminated dust and debris from the abatement.

- Decreased exposure to children attending COF during, and immediately following, abatement due to the occupancy protection plan and cleaning up lead contaminated dust and debris from the abatement.

- Decreased long term lead exposure to current and future residents of abated housing due to proper identification and permanent abatement of lead-based paint hazards in the dwelling.

- Decreased long term lead exposure to current and future children attending abated COF and schools due to proper identification and permanent abatement of lead-based paint hazards.

- Additional decreases of occupational exposure (beyond that provided by OSHA worker protection regulations) to inspectors, risk assessors, and abatement supervisors and workers from training in, and adherence to, work practice standards for inspection, assessment, and abatement procedures.

- Decreased exposure to other people who live, work or travel near to abatements due to all lead-based paint activities being performed by trained workers following the work practice standards.

- Decreased ecological damage from lead exposure from abatement due to the work practice standards including proper containment and clean-up requirements.

Quantitatively estimating the physical and monetary benefits of the rule requires considering two inter-related issues: the number of abatements using properly trained abatement personnel that will occur after this rule is implemented, and the changes in the human health and ecosystem damages associated with exposure to lead in paint and soil. As previously described in Chapter 4, the number of voluntary abatements that will occur in the future using trained labor could potentially be larger or smaller than the currently observed level. The direction of change is not known *a priori* due to the potential for a shift in both the demand and supply of abatements. While individuals making the voluntary decision of whether or not to abate a residential unit or a child occupied facility (COF) will have better information about the quality of the lead-based paint services being offered, and the quality that will be offered will be better than the currently offered services, the cost of lead-based activities will also increase. The costs of the rule will tend to decrease the market clearing quantity of abatements; however the quantity will be increased by changes in the demand for abatements due to changes in abatement quality and consumer information. Chapter 4 presents an estimate of the net impact, indicating that a net increase in the national number of abatements will occur based on information developed from an existing state level program in Massachusetts. This chapter uses the same estimated number of abatements (55,045 residential units and 500 COFs abated per year) to explore the possible benefits of the rule.

The approach taken in this chapter is to examine the benefits associated with risk reductions caused by abating lead in paint and soil. In order to quantify the benefits of §§402(a) and 404, information must be collected about the magnitude of the expected risk reductions attributable to the provisions of §§402(a) and 404 for each health effect, and the size of each population that will enjoy the risk reduction. The extent of risk reduction to the ecosystem must also be identified. In addition, estimates of the value of the health effects, appropriately measured by the willingness to pay to avoid the effect, must be available. Willingness to pay to avoid health effects includes the direct medical cost of treating the health effect, any lost income associated with the treatment of (and recovery from) the health effect, the costs of any required lifestyle changes (diet, exercise, etc.), and the additional willingness to pay to avoid the pain, discomfort and worry associated with the health effect. It is not possible to conduct a comprehensive quantitative estimate of the benefits of a reduction in lead exposure at this time. However, this chapter uses an alternative approach that quantifies a portion of important health effects. Exposure analysis (including estimates of lead uptake in the human body for a given set of paint and soil conditions), dose response functions and valuations are only available for a limited set of the known and suspected health effects. The lack of exposure and dose-response functions limits this and other EPA benefit analyses of the effects of lead to coverage of only a portion of the health effects, and none of the ecological damage. In addition, the available dose-response information is for long-term elevated blood lead levels. Little information is available about the impacts of short-term exposure to high lead levels, such as a resident or other person in the vicinity might experience during (and immediately after) an abatement.

In order to conduct a limited benefit analysis of §§402(a) and 404 using the available quantified dose-response functions, the essential information that is needed is the "with and without" mean blood lead levels in each affected group of people, as well as the number of affected people in each group. In practical terms, a benefit analysis needs to have the before and after blood lead levels attributable to the §402(a) standards and training for residents (levels attributable to the differences in the long-term exposure from doing the abatement properly) and for all other people in the vicinity of the lead-based paint activities. As described in Chapter 3, the quantified exposure information necessary to estimate these blood lead level changes directly related to the training and standards is not available.

An alternative approach that is developed in this chapter is to attempt to develop a benchmark of the *potential* magnitude of the rule's benefits by estimating certain elements of the quantifiable benefits to residents of conducting a typical target housing abatement. That is to say, instead of estimating the *incremental* benefits associated with provisions of the rule, this chapter estimates the *total* measured benefits (albeit with many potentially important benefit categories excluded) of performing an abatement. Clearly §§402(a) and 404 will be directly responsible for only a portion of these total measured benefits. The total measured benefits from an abatement may be substantially higher than the incremental benefits associated with the §402(a) training and standards. However, estimating the total measured benefits can help bound the incremental benefits issue and provide a basis for qualitatively examining the potential net benefits of the rule. If the estimated total benefits of the rule are substantially greater than the incremental costs, the likelihood of potential positive net benefits increases. For example, if the estimated complete abatement benefits were 100 times greater than the §§402(a) and 404 per-abatement costs, then the §§402(a) and 404 regulations would have to increase the benefits of abatement by one per cent to provide a net increase in benefits. The basis for such an intuitive check is provided in the Chapter 8 benefit-cost analysis by directly comparing the measured complete benefits of abating paint and soil with the measured costs of the §§402(a) and 404 regulations. If the measured complete benefits of paint and soil abatements do not exceed the costs of the regulation, then it would clearly be impossible that the portion of the total benefits directly attributable to the regulation will exceed the costs. If the complete benefits of abatement exceed the §§402(a) and 404 costs, then information on the known effects of poorly performed abatements can be used to qualitatively assess whether the portion of the complete benefits directly caused by §§402(a) and 404 are likely to also exceed the §§402(a) and 404 costs.

6.1. Quantified and Unquantified Benefits Categories

Most of the remainder of this chapter describes the estimation procedure used to prepare a partial estimate of the benefits of abatement, and the results of applying that procedure to the §402(a) rule using available information. Quantitative physical and monetary benefit estimations are developed for only one population subgroup potentially subject to these effects: neurological (intelligence) damage to infants and children less than 7 years old living in abated residential units and visiting COFs. This limited quantitative coverage omits a wide range of other affected people, as well as all benefits other than human health. The remainder of this section discusses some of these important omitted categories.

Estimating the §§402(a) and 404 benefits of the impact of training and performance standards on the risks to workers is difficult. There are estimates of the changes in worker blood lead levels, and there is limited information on dose-response and valuation information for health effects of concern. Such information was developed by OSHA in connection to the promulgation of the Personal Exposure Limit for workers exposed to lead (including abatement workers). However, it is difficult to estimate the *incremental* effects of §§402(a) and 404. In order to avoid "double counting" the worker benefits attributable to the OSHA PEL rule, the worker benefits were not estimated in this analysis.

Another potentially important benefit category is avoided neonatal mortality of infants less than one year of age from avoided maternal exposure in abated units. There is considerable uncertainty about the impact of abatements on maternal blood lead levels, and more uncertainty about the incremental impact of §§402(a) and 404 on maternal blood lead. However, the potential monetary benefits of neonatal mortality are substantial. Because of the increased uncertainty about the changes in maternal blood lead levels, the magnitude of the physical and monetary benefits are less certain than the neurological impacts on children, and are presented as a sensitivity analysis in Chapter 7.

Another population subgroup that is not quantified is adult residents of housing units that are abated. Although there is documented evidence that adult residents of housing with high levels of lead-based paint do have elevated blood-lead levels, there is insufficient information available to perform an exposure analysis which would estimate a quantified relationship between the presence of lead-based paint and/or lead contaminated soil and the blood lead levels in adults. If such an exposure analysis were possible, dose response functions for adults (in specific age ranges) are available for very serious health effects including stroke, coronary heart disease and mortality. In other EPA regulatory analyses concerning lead where it was possible to quantify the changes in adult blood lead levels associated with reductions in exposure to lead, the relatively high willingness-to-pay estimates to avoid these very serious adult health effects have resulted in adult benefits being the dominant benefit category. The potential magnitude of benefits associated with adult target housing exposure are discussed and calculated as part of the sensitivity analysis in Chapter 7. Chapter 7 presents the monetary benefits estimates for two changes in adult blood levels: a relatively small change (0.1 μg/dL) and a large change (2.13 μg/dL).

A third possible population subgroup that is omitted from this analysis that may experience substantial health benefits from §§402(a) and 404 are the families of lead abatement workers. Well documented cases exist of children and adults with severely elevated blood lead levels where the exposure mechanism was identified as lead-contaminated dust brought into the household by lead abatement workers. The standards and training requirements of §§402(a) and 404 will directly reduce this exposure route.

Another potentially very important type of benefit may occur from requiring that inspections, lead hazard screens, and risk assessments be conducted by trained and certified inspectors or risk assessors, as appropriate. A qualified inspector or risk assessor may conclude that an abatement is not needed. Residents who are concerned (based solely on the house's age and condition) about a possible lead exposure health risk may be relieved if a credible inspector or risk assessor finds there is no lead-based paint risk in their house. The peace of mind these residents experience from knowing there is no risk to themselves or their children is a benefit that may exceed the cost of the inspection, lead hazard screen, or risk assessment. In addition, unnecessary abatements may be avoided. Some of these benefits may be reflected in the market value (rental or sale price) of the property that could then be marketed as not requiring an abatement.

It should be emphasized that the Section 402(a)/404 regulations do not require that occupants abate lead-based paint hazards; rather the requirements of the rule ensure that trained and certified inspectors and risk assessors will conduct inspections, lead hazard screens, and risk assessments. The value of having a trained and certified individual identify the lead hazards in a person's home or child-occupied facility include: the identification of all lead-based paint hazards within the unit; better targeted response actions based upon the relative risks of the various lead hazards in the unit; and appropriate recommendations for responding to lead-based paint hazards in the unit. Each element is contingent upon the information provided by the inspector and/or risk assessor and to the extent that trained and certified individuals provide better information for responding to lead hazards, benefits will accrue to the Rule. The improved information flow includes information about the absence of hazard so that unnecessary abatements will not be undertaken.

In addition to adverse human health effects, lead can impose substantial adverse effects on ecosystems. Although lead occurs naturally in the environment, it plays no known beneficial role in biological processes. In fact, lead is a natural toxicant that affects a broad spectrum of species and persists in the environment. Elevated ambient lead levels that are bioavailable can seriously disrupt flora and fauna populations and ecosystem dynamics. As a result, lead is considered a particularly hazardous ecotoxicant. Improperly performed abatements in COFs and residential buildings can introduce lead into the general environment through both on-site contamination (from dust and debris) and from improper permanent disposal of lead-contaminated debris.

In general, ecotoxicological effects are studied at three levels. First, at the level of the individual organism, toxicity measurements are made of lethal and sub-lethal doses. From these measurements, it is often possible to derive exposure indicators that permit estimation of species-specific toxicological effects, including mortality. Effects on other population parameters include effects on population dynamics, such as mortality and morbidity per age-group, dietary patterns, and sex distribution. Such information is especially important in determining population stability. Finally, the impact of a contaminant on biological systems can be evaluated. System-level studies attempt to incorporate the impacts of a contaminant on multiple species in order to estimate the overall effects on ecosystem productivity, nutrient cycling and other related qualities.

Studies of the ecotoxicity of lead have tended to focus on one species at a time, making generalizations to all species difficult. In aquatic species, exposure to lead may result in a variety of responses. Lead compounds may inhibit growth of marine algae and other microorganisms. In aquatic microorganisms that consume algae and that in turn form a food base for most aquatic food chains, adverse reproductive effects are evident at low lead levels. Fish experience anemia, spinal curvature and deterioration and death due to the buildup of mucus over the gills in response to varying lead concentrations. In species especially susceptible to lead poisoning, such as rainbow trout, small concentrations can result in lethal outcomes. This in turn can result in substantial losses to the sport fishing industry.

Terrestrial plants generally accumulate lead from the soil through the root system. This process is enhanced in soils that are acidic and those with low organic content. Also lead is deposited onto leafy surfaces of terrestrial plants. The effects of lead exposure on plants include inhibited plant growth, reduced photosynthesis, and reduced water absorption. Terrestrial invertebrates may be exposed to lead by consuming contaminated plant and soil litter.

In birds, lead poisoning due to ingestion of lead shot, and prey contaminated with lead, have been documented since the late 1800s. The toxic effects of ingested lead include nervous system damage, kidney and liver damage, paralysis and inhibition of heme synthesis — all may lead to death. These concerns about fish and birds are manifested through the lead shot and lead sinker regulations.

As with other taxa, mammalian susceptibility to lead's toxicological effects varies by species and by individual. Generally, the effects of lead on mammals parallel those documented for humans. Mammalian exposure to lead occurs primarily through ingestion, with inhalation playing a secondary role. Lead is one of the most common causes of accidental poisoning in domestic animals. Of the domestic species commonly subjected to lead poisoning, cattle experience the greatest toxic effects.

The second level of ecotoxicological effects (i.e., population effects) of lead poisoning are best studied in birds. Lead poisoning in waterfowl has been documented in at least sixteen countries, mainly from ingestion of lead shot and lead fishing weights. As with sport fishing, reductions in bird populations can result in recreational losses and losses to the hunting industry.

An example of the ecosystem impacts of lead contamination may be seen in its combined effects on terrestrial plants and invertebrates. Lead contamination can seriously affect populations of detritovores (i.e., organisms that consume organic litter) living on foliage and in the soil. In addition, high levels of lead in the soil are known to affect both soil inhabitants and plant productivity. Collective damage to these groups of organisms disrupts the cycling of nutrients through an ecosystem, resulting either in the often undesirable displacement of lead-intolerant species with lead-tolerant species, or in the loss of energy and nutrients from a system and the subsequent decrease in productivity. Such effects may result in economic losses in agricultural and silvicultural systems.

6.2. Risk and Benefit Modelling

The risk assessment modeling procedures, information sources, and assumptions used to estimate the incidence of adverse health effects resulting from exposure to lead present in paint, soil, and dust in target housing settings are described in this section. This risk assessment model is used to support the analysis of §§402(a) and 404 by determining both the baseline incidence of health damages expected in the absence of lead-based paint actions, and the benefits that will result from various exposure reduction actions that may result from these activities.

The risk assessment modeling has three major components:

- Characterization of lead exposure from target housing paint, soil, and dust;
- Calculation of blood lead distributions resulting from these exposures; and
- Prediction of the incidence of adverse health effects associated with the blood lead distributions.

Each of these components of the risk assessment model is discussed in the ensuing sections of this chapter. First, however, it is important to discuss some of the key underlying assumptions and premises for the risk assessment model.

A basic premise of the §§402(a) and 404 benefit analysis is that individuals making private, voluntary decisions about whether to abate are not fully informed about the risks of lead to their families or tenants. The approach used here to determine who abates, and what kind of abatement is performed, is parallel to the cost analysis described in Chapters 4 and 5.

The benefit analysis assumes that if a housing unit is found, through an inspection and/or lead hazard screen or risk assessment, to have a maximum interior lead-based paint level greater than or equal to 1 mg/cm^2 and the paint is in deteriorated condition (defined as at least five square feet of damaged lead-based paint occurring somewhere in the housing unit), or if the paint is in good condition but on friction surfaces such as doors and windows, the housing unit is a potential candidate for abatement. Similarly, if the average soil lead level is greater than 5,000 ppm, the housing unit is a candidate for a soil abatement. If the soil level exceeds 5,000 ppm and the exterior paint is lead-based paint (defined as lead-based paint greater than or equal to 1 mg/cm^2, regardless of the interior paint level or condition), the exterior paint would be abated if the soil is abated in order to remove the presumed source of lead in the soil. If both the interior lead-based paint level and conditions and the soil level exceeds these levels, the housing unit is a candidate for both an interior paint and soil abatement (with exterior paint also abated as needed). In addition, housing units with interior lead-based paint in good condition, but occurring on friction surfaces (window frames, doors, etc.) are considered as possible candidates for abatement. As described below, the specific assumptions about dust intake result in identical estimated physical and monetary benefits for friction surface abatements and for complete abatements unless pica is present. Pica is a craving for unnatural food, such as chalk or ash. In the context of this report, pica behavior is defined as eating paint chips, and thus probably ingesting lead. Lead-related health damage from pica is assumed to be possible only if lead paint is in bad condition. Although only a small percent of children are assumed to exhibit pica (as described below), those children are at much greater risk of lead damages if they have access to damaged lead-based paint than they would be if they lived in housing with lead paint in good condition.

A very important element in the §§402(a) and 404 analysis is the group of assumptions about the presence of infants and children in the housing unit. Infants receive the most benefit from any abatement because:

(1) the assumed uptake of lead is higher in infants (due to increased hand-mouth activity) than other children,
(2) the negative health effects of lead are believed to be greatest on younger children, and
(3) the child may live in the abated house throughout the ages of known risk (birth through age six), while older children will live in the abated units for fewer "at risk" years.

Assuming that an inspection and/or risk assessment only occurs if a newborn child lives (or is about to live) in the house would substantially increase the measured benefits. This "just in time" modelling assumption would maximize the benefits that could be achieved for each individual house. However, current experience indicates that many abatements occur without a newborn child involved. Some abatements are done in response to a discovered high blood lead level in an older child living in a housing unit with elevated levels of lead-based paint or soil (such abatements are mandatory under several state programs, including Massachusetts). Other abatements may occur because owners (either owner-residents or investors) may be concerned about potential marketability of the property (potential buyers or renters will avoid housing with potential exposure to lead-based paint) or future liability concerning the dangers of lead-based paint.

Although the assumption that there will immediately be a newborn child in every housing unit that is abated does not match current observed behavior, an assumption that abatement decisions are made completely ignoring the presence of children is not reasonable either. Much of the public awareness of the dangers lead-based paint concerns children's exposure to paint. Therefore, it is reasonable to conclude that housing units that are voluntarily abated are somewhat more likely to have children living in them at the time of the abatement than the national average housing unit. This reasonable assertion is implemented in the analysis by assuming that in the year in which the abatement occurs, houses that are abated are twice as likely to have children under the age of seven as the average household. Bureau of Census data indicate that almost 18 percent of all housing units[1] in the nation have one or more children less than age seven living there. Some units obviously have more than one child living there. Doubling the likelihood of children residing in a unit at the time of the abatement is implemented in the analysis by assuming that there is a 35 percent probability of one or more children living in an abated unit at the time of the abatement. Thus there is a 65 percent probability that there will not be any children living in a newly abated unit. This "starting point" assumption influences the likelihood of children residing in the recently abated house for up to six years. After the initial year, however, the birth rate of new children into the abated houses is assumed to be the same as the national average birth rate. Thus by the seventh year (after all the pre-existing children have passed age seven) the abated houses have the same expected number of children as the national average.

This analysis recognizes that the presence of lead in paint, soil, and dust is a long-term environmental problem. Even though lead-based paint has not been legally used for interior target housing purposes since 1979, and major historical sources of lead deposition to soil (such as automotive emissions from leaded gasoline) have been eliminated or severely curtailed, the existing stock of lead in paint, soil and dust from these past sources will remain a major source of exposure to children for many generations. Consequently, the risk assessment model addresses not only the exposure and health risks to those children currently living in lead-contaminated residences, but also the risks to children who will be born into these units over the next several decades which would result from not undertaking abatement action.

To incorporate this consideration, the risk assessment model is built around the concept of annual cohorts of children being born into abated units over the next 50 years. Based on Bureau of the Census population projections and assumptions about the rate at which abated units are destroyed or otherwise removed from service, the model incorporates estimates of the number of pre-1980 residential units in use[2], and the number of newborn children residing in the abated unit each year for each year of the subsequent 50-year occupancy period. It is convenient to view the modeling conceptually as involving an iterative, stepwise process where separate calculations are made of the incidence of adverse effects for each of these 50 annual cohorts, and then summed to obtain the total for the full modeling period. The modeling process determines the incidence of these adverse effects for

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[1]Census figures indicate that 25.4 percent of all families have children less than age seven. However, §§402(a) and 404 is not limited to residential units occupied by families. Abatement may be performed on any target housing unit regardless of who occupies it. Better targeting of abatements that will likely occur due to a complete risk analysis of each situation is likely to increase the percentage of abated housing units with children at the time of abatement, and the likelihood of children living in the abated house in the future. This would increase the benefits.

[2]The term "target housing" is defined in Title X as housing constructed prior to 1978. Data limitations, however, require the use of pre-1980 housing stock.

newborns in the housing unit at the time of the abatement. The effects on the first year cohort are then extrapolated using factors reflecting the changes in the housing stock characteristics and birth rates over the remaining 49-years of useful life of the unit to obtain the full results for a single abatement.[3]

Therefore, most of the discussion in this section focuses on the first year of the analysis. The derivation of the factors used to inflate the first year results to the remaining useful life of an abated unit are also presented in this section.

The terms "baseline" and "first model year" are used throughout this section. These are not synonymous terms. Baseline refers to the analyses of exposure and incidence of adverse effects assuming there are no Title IV-induced changes. Subsequent analyses are performed assuming different types of exposure reduction actions induced by Section 402(a) to compare with this baseline. First model year simply refers to the results of either the baseline analysis or the alternative exposure assumption analyses for the first model year of benefits, which occur in the second year the rule is effective. In all cases, the first year effects are computed first, and those results are then extrapolated to the full 49-year modeling time frame.

6.2.1 Characterization of Exposure

The purpose of the exposure characterization component of the model is to define the distribution of lead levels in paint, soil, and dust in privately-owned housing stock in the U.S. The exposure assessment also addresses other characteristics of these residences that affect children's exposure, particularly the condition of the lead-based paint.

The distribution of current lead levels in paint, soil and dust in the U.S. housing stock is derived from the results of the survey sponsored by the EPA and by the U.S. Department of Housing and Urban Development (HUD). That survey was conducted in 1989-1990 to provide better estimates of the extent of lead-based paint hazards in the nation's private housing stock. The results of that survey have been detailed by EPA *Report on the National Survey of Lead-Based Paint in Housing* (EPA, 1995), and HUD in its December 1990 Report to Congress entitled *Comprehensive and Workable Plan for the Abatement of Lead-Based Paint in Privately Owned Housing* (HUD, 1991).[4]

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[3]The impacts of the rule are analyzed in this RIA over a 50-year period (1997 through 2046), with training costs starting in the first year the rule is effective and continuing through 2046. The work practice standards costs, and all benefits, come from abatements which commence in the second year the rule is effective (1998) and continue each year through 2046. Once an abatement occurs, benefits from that unit or COF are assumed to occur over the next fifty years (unless the unit or COF is destroyed or otherwise removed from service). For example, a unit abated in the final year modelled in this analysis (2046) generates quantified monetary benefits through the year 2095. The present value of these benefits are discounted and included in the estimated present value of the benefit stream.

[4]The data are described in Appendix 4.C of this RIA.

The primary input files for the risk assessment model contained 284 HUD sample housing unit records with the three lead values (interior paint XRF, average soil concentration and average dust concentration), and the HUD weight for extrapolating the expected frequency of units with similar lead values to the full 77 million pre-1980 national dwelling units in use in 1990. However, between 1990 and the first year that benefits are modeled (1998), some of these residences will be demolished or abandoned. The annual attrition rate is assumed to be 0.5 percent per year (applied to all houses, regardless of age). Hence in 1998 74.2 million pre-1980 housing units will be in use. The same annual attrition rate is assumed to continue in the future, steadily diminishing the size of the remaining target housing stock. This same annual attrition rate is also assumed for units that are abated, creating the possibility that an abated house will not be in use for fifty additional years after the abatement occurs.

The total stock of privately-owned and occupied dwellings in the first year that benefits are modeled (1998) is approximately 95 million. This implies approximately 19 million units built from 1980 through 1994 are still in use, in addition to the approximately 74 million housing units still in use built prior to 1980 (see Section 6.2.2 for additional discussion of the housing data). Although housing built after 1980 may have elevated soil lead levels, they are not included in the definition of "target housing" for §402(a), and are therefore not included in this analysis. While it is likely that if a voluntary soil abatement is performed on a post-1980 house the work will be performed by trained labor, the use of trained and certified labor is not required by §402(a) for post-1980 housing. Therefore, neither the incremental costs nor the benefits of using trained labor to abate the soil in post-1980 houses are directly attributable to Title IV.

6.2.2 Universe of Housing Stock with Lead-Based Paint and Lead Contaminated Soil

According to inferences made from HUD data, only about 35 percent of the target housing stock have maximum interior lead-based paint levels greater than or equal to one (see Exhibit 6.1). These housing units are considered to be candidates for abatements. Of these, about 6.1 million housing units (about 8.2 percent) have lead-based paint classified in deteriorated condition (defined as having at least five square feet of lead-based paint in poor condition). The direct ingestion of lead paint (pica) by children is assumed to only be possible with paint in bad condition. Thus nearly 24 percent of the eligible housing units could cause the damages associated with pica (if a child occupying the house exhibits pica, as described below). An additional 7.7 million units (about 10.3 percent) have lead-based paint in good condition, but occurring on friction surfaces (windows, door jams, etc.) HUD data implies that nearly 12 million housing units (about 16 percent) have lead-based paint, but the paint is in good condition and is not on friction surfaces. A small portion of all the pre-1980 dwellings in use (about 330,000 units or 0.4 percent) have soil lead levels equal to or exceeding 5,000 ppm. The small number of housing units in the original HUD sample with soil lead levels greater than or equal to 5,000 ppm results in increased uncertainty regarding estimates of the national number of housing units eligible for soil abatements, and about the joint distribution of soil and interior paint conditions for those units.

Exhibit 6.1: Distribution of Pre-1980 Construction Private Homes, by Maximum Interior Lead Paint Content Level, Paint Condition, and Soil Lead Levels (Percent of Total pre-1980 Housing Stock)		
Maximum Interior Lead Paint Level	**Soil Levels < 5000 ppm**	**Soil Levels ≥ 5000**
Lead Paint Content < 1 mg/cm^2	65.1%	**0.2%**
Lead Paint Content ≥ 1 mg/cm^2		
Lead Paint in Good Condition, Not on Friction Surfaces	15.9%	**0.1%**
Lead Paint in Good Condition and on Friction Surfaces (windows, doors, etc.)	**10.3%**	**<0.1%**
Lead Paint in Bad Condition	**8.2%**	**<0.1%**
Total	99.6%	**0.4%**
Housing Units in **bold** are potential candidates for abatement. Total eligible housing units = 13.9 million (19 percent of total)		

The analysis stratified the 284 HUD samples into additional subdivisions to reflect characteristics that affect exposure from interior lead-based paint in these units. Of the 284 original HUD sample housing units, 104 were found to have some interior lead-based paint present, or soil lead levels greater than 5,000 ppb, or both. Each of the HUD sample housing units represents a specified portion of the national housing stock, with a weight assigned to each sample to reflect the number of similar houses in the national stock. In order to conduct the §402(a) benefits analysis, each portion of the national housing stock represented by a single house was divided into subgroups as described below. Note that the paint, soil and dust levels in each subgroup are assumed to be identical to the conditions in the HUD sample unit representing the group.

The original HUD survey found that a small portion (208 of the 2,178 original samples) were anomalous, and were "trimmed" from the data set. The anomalies included samples with unusually large values for both the weight of the dust sample and the lead content of the dust. Because the anomalous dust readings may represent errors, dust readings of greater than 100,000 ppm, and loading of greater than 2,000 mg/foot^2 were eliminated. Similar "trimming" procedures are used in this RIA. The "trimming" did not eliminate any residential units from the analysis. Trimming individual dust samples effects the calculated average dust level in a unit. However, the HUD survey also truncated all soil levels at 2,600 ppm of lead. This affected all individual soil samples up to 43,000 ppm. The HUD survey noted that "there is no reason to believe that the large readings are not factual" (Appendix II, p. 3-40), but merely were not useful in an analysis of the precision of the laboratory work. Adopting such procedures in the current analysis would eliminate all average soil samples greater than 5,000 ppm, reducing both the estimated costs and the benefits of the §402 rule. Because the high soil samples are believed to be accurate, all soil samples are retained in this analysis.

Using HUD data, the total weight in the national sample for each sample house was divided into four categories to reflect the likelihood of the presence of newborn or existing children. The total weight in the national sample was divided into one group to represent a house having a newborn, one group representing households with existing children less than age seven but not a newborn, one group with both newborns and existing children, and one group with no children. In order to incorporate the assumption that a housing unit currently without a newborn or children less than seven is only half as likely to be selected for an abatement as houses with children, the sample weight for this group is divided by two. Thus the resulting "adjusted abatement pool" includes:

- 1.2 percent of all residential units having both newborns and existing children;
- 5.4 percent of units having a newborn, but no existing children;
- 28.5 percent having existing children, but no newborn, and;
- 64.9 percent of the units having no children.

The dwellings having a combination of both lead-based paint in deteriorated condition and pica children are particularly important for the risk analysis. Based on the HUD survey, 24 percent of the housing units in each category are assumed to include paint in bad condition, creating conditions conducive to damages from pica. For these children, the model used to predict blood lead levels (as described below) included special input assumptions for paint chip ingestion, as well as for exposure through dust and soil ingestion.

Having the housing stock fully stratified and properly weighted to account for the 74.2 million target dwellings in 1998, the model then applied the estimated birth rate[5] value of 3.994 percent for 1994 to determine the number of units in each strata expected to have a child in the first year. Blood lead distributions, and the incidence of adverse health effects were then computed for the children in each of the categories of housing units comprising the first year cohort.

6.2.3 Determining Blood Lead Distributions

For each of the housing samples created in the model, an estimate was made of the geometric mean blood lead level for the children born into them, all of whom are assumed to

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[5]The birth rate is estimated by dividing the estimated 1994 population less than age one (3.91 million) from *Population Projections of the United States by Age, Sex, Race and Hispanic Origin: 1992 to 2050* by the predicted number of occupied housing units in 1994 (97.94 million) from the *Forecast of Housing Activity*. A lower birthrate is used to predict the likelihood that newborns will occupy an abated housing unit in the future. The combination of a lower birth rates in the future and a larger housing stock reduce the estimated future birth rate in abated target housing units to close to 3.5 percent per year.

live in those dwellings from birth through at least age seven. The geometric mean blood lead estimates were obtained using EPA's Integrated Exposure, Uptake and Biokinetic Model for lead, hereafter referred to as the IEUBK model.

The IEUBK model has been developed by EPA to use as a tool for estimating the risk of elevated blood lead in populations of children exposed to various levels of lead in environmental media. The IEUBK model has been under development for several years, and has been available in several interim versions. The latest version of the IEUBK model is used for this analysis (Version 0.99d), which was released in February, 1994.

The IEUBK model is designed to estimate the geometric mean (GM) of the distribution of blood lead levels for a population of children exposed to similar environmental concentrations of lead in air, water, diet, soil, household dust, and "other" exposure sources. In accordance with the IEUBK Guidance Manual Technical Support Document (EPA, December, 1994), variability in blood lead levels among individuals within such a population of children exposed to similar environmental levels is accounted for by assuming that the blood lead distribution is lognormal. The IEUBK Guidance Manual provides an estimated default value of 1.6 for the geometric standard deviation (GSD) to describe individual variability in a population of similarly exposed children.

The reductions in lead exposure obtained through abatements in this analysis are assumed to occur prior to the exposure occurring (with one important exception). All children living in the house after an abatement occurs are never exposed to that portion of lead exposure the analysis assumes is reduced by an abatement. Thus the IEUBK model in this application is estimating blood lead levels in these children assuming chronic exposure to the reduced lead level. Such an application is fully consistent with the primary purpose of the IEUBK model to simulate blood lead levels from chronic exposure.

The one exception to the chronic exposure is children already living in the abated housing unit at the time the abatement occurs. These children will have been exposed to elevated levels during the time they occupied the un-abated units. Additional exposure could have occurred from lead transferred from the mother to the fetus *in utero*, if the mother lived in the un-abated unit during pregnancy. The abatement will reduce the child's subsequent exposure, but the implications on the blood lead levels and the resulting health effects for such children are less certain than in the never-exposed situation. In order to account for the possible reduced effects changing the exposure for existing children, the analysis assumes that the monetary benefits for existing children are only half the size as the estimated benefits for newborns. The overall uncertainty this introduces into the model is mitigated by the assumption that the abated housing unit will be occupied for fifty years after the abatement (unless the house is removed from use). The existing children will only influence the calculated benefits until they turn seven. Assuming the average age of an existing child is 3.5 years old, the benefit stream for housing units with existing children consists of 3.5 years including effects on the existing children, and 46.5 additional years without the existing children. As described above, less than thirty percent of the abated units are assumed to have newborns or existing children at the time of the abatement.

Exhibit 6.2 summarizes the IEUBK input assumptions used for this analysis. The exhibit presents assumptions made regarding levels of lead in each medium, daily intake of those media, and absorption of lead from each source. The recommended default values provided in the IEUBK Guidance Manual Technical Support Document (EPA, December, 1994) are used in all cases except for the absorption rate from paint chips ("Other dietary intake"). The Guidance Manual does not provide a default absorption factor value for paint chips; it is assumed to be 10 percent (0.1) for the current analysis based on discussions with EPA staff (K. Hogan, August, 1995). The levels of lead in air and water, and the dietary intake values are uniform for all children, using the values shown in Exhibit 6.2. The input values for soil and dust are those in each housing group obtained from the HUD data as described above.

No information was found in the published literature on the average daily intake of lead from the ingestion of paint chips among children with pica behavior. It was therefore necessary to rely on several assumptions to arrive at an estimated daily intake to use as input to the IEUBK model for this source of exposure. As pointed out in the IEUBK Guidance Manual, the estimate of lead intake from paint chip ingestion depends in part on the amount of lead in those paint chips.

Referring to a calculation from an EPA Lead Reference Materials Workshop using the assumptions of a seven-layer thickness of paint and a density of 2 g/cm^3, the Guidance Manual estimates that an XRF reading of 1 mg/cm^2 corresponds to a lead concentration of 5,000 μg/g. A seven layer thick chip with an area of 1 cm^2 and a lead loading of 1 mg/cm^2 would contain 1 mg (1,000 μg) of lead.

In addition to the amount of lead in the chip, the amount of lead ingested is also a function of the typical size (mass) of the chips ingested and the frequency at which paint chips are consumed. Elias (1993) provided an estimate that children ingesting paint chips ingest an average of 2.5 chips per week, with each chip averaging 1 cm^2.

Combining these assumptions, the current analysis results in an estimate of average daily intake of 357 μg/day for an XRF reading of 1 mg/cm^2 (an XRF reading of 2 would result in twice this amount, or 714 μg/day, and so on):

$$\textit{ntake per XRF } (\mu g/day\ per\ XRF) = XRF\ (mg/cm^2) \cdot \frac{1000\mu g}{mg} \cdot \frac{1\ cm^2}{chip} \cdot \frac{2.5\ chips}{week} \cdot$$
$$= 357\ (\mu g/day\ per\ XRF)$$

As indicated in the previous section, residences with lead-based paint were stratified to isolate the subset of children ingesting lead-based paint chips. The HUD data estimated

Exhibit 6.2: Summary of Parameter Values Used in IEUBK Model (Ver 0.99d)

Air Parameters: All air parameters are Guidance Manual default values.
Vary air concentration by year? No
Outdoor air lead concentration (μg/m^3): 0.10
Indoor air concentration (% of outdoor value): 30%

Diet Intake Parameters: All diet parameters are Guidance Manual default values.

Age:	0	1	2	3	4	5	6
Diet Intake (μg/day)	5.53	5.78	6.48	6.12	6.01	6.34	7.0

Water Intake Parameters: All water parameters are Guidance Manual default values.
Drinking water concentration = 4 μg/L

Age:	0	1	2	3	4	5	6
Drinking Water consumption (L/day)	0.2	0.5	0.52	0.53	0.55	0.58	0.59

Soil and Dust Intake Parameters: Soil and dust levels are input based on HUD data. All other parameters are Guidance Manual default values.

Soil/dust ingestion weighting factor: 45% soil / 55% dust

Age:	0	1	2	3	4	5	6
Total soil + dust intake (g/day)	.085	.135	.135	.135	.1	.09	.085

Absorption method values: All values are Guidance Manual default values except for "Absorption from Alternate Sources" (i.e., Pica)

	Total Absorption (percent)	Fraction of Total Absorption Assumed Passive Absorption
Soil	0.3	0.2
Dust	0.3	0.2
Water	0.5	0.2
Diet	0.5	0.2
Alternate (Paint Chips)	0.1	0.2

that 24 percent of residences with interior lead-based paint have non-intact paint. The analysis also assumes that 10 percent of children exhibit pica. This assumption is based primarily on Mahaffey (1993) who provided an estimate of pica incidence of 11 percent among children 0.5 to 3 years old based on an analysis of data from the NHANES II. Other estimates of pica frequency have also been reported. For example, Barltrop (1966) is cited in HUD (1991) as reporting that the frequency of pica among children in inner cities is 20-30 percent. Lacey (1990) provided a review of various reports estimating the frequency of pica behavior in various population groups. Lacey cited a report by Robischon (1971) which indicated pica (not limited to paint chips) occurred in up to 50 percent of black children and 37 percent of white children. Robischon also reported her own empirical findings that pica occurred in 37 percent of a targeted group of 90 black children ages 19 to 24 months. Lacey also cited findings from Halsted (1968) indicating that the frequency of pica behavior was stable in the range of 25 to 33 percent among young children, with a higher frequency among black children.

The combined conditions of non-intact paint and pica children therefore implies an overall estimate that 2.4 percent (i.e., 10 percent of 24 percent) of children in target housing units with interior lead-based paint will ingest lead-based paint chips. (Note also that only about 35 percent of target housing units are expected to have interior lead-paint with XRF levels at or above 1 mg/cm^2. Therefore, less than one percent of children born into target housing are expected to experience exposure to lead from direct paint chip ingestion.)

The reductions in blood lead levels due to paint abatement estimated for this analysis arise primarily from two sources: reduction in lead intake from paint chip ingestion (for children with pica living in homes with lead paint in poor condition), and reductions in lead intake from dust ingestion. The abatement of lead-based paint eliminates the potential for direct paint chip ingestion. The abatement of lead paint also, typically, results in a reduction in the assumed dust lead concentration in these homes relative to that observed in the HUD survey. In accordance with default values provided in the IEUBK Guidance Manual, it is assumed that the dust lead concentration in homes having undergone paint abatement will become equal to 70 percent of the associated soil lead concentration. In some cases, however, that calculated value would exceed the dust lead concentration value actually observed in the HUD survey. In those instances, the lower HUD value is used for the post-abatement dust concentration rather than the value based on 70 percent of the soil concentration.

The IEUBK model provides age-specific estimates of the geometric mean blood lead for given exposure conditions at ages ranging from birth through 7 years. For this analysis, the blood lead geometric mean predicted for age 3 was selected for use in estimating health damages. This age was selected because blood lead levels tend to peak at this age. It is also consistent with assumptions that cognitive effects are expected to occur only after having elevated blood lead levels for a period of 3 to 4 years.

As noted previously, the IEUBK produces an estimate of the geometric mean for an assumed lognormal distribution of blood lead levels for the population of children exposed to similar environmental levels of lead. In this risk analysis, geometric mean estimates are made for each separate population of children based on the stratification of dwellings as described above. The analysis in this report is conducted for 284 separate subpopulations exposed to similar exposure conditions in the 284 HUD sample residential units. The health effects and monetization results of the estimated changes in the 284 exposure profiles are then adjusted by the HUD sample weights and assumptions on the presence of children to estimate the national benefits. This application of the IEUBK model is consistent with the Guidance Manual recommendation to use the IEUBK model to estimate individual variation in blood lead levels expected to occur in a population exposed to similar exposure conditions.

6.2.4 Estimated Incidence of Adverse Health Effects

The estimates of the incidence of adverse health effects resulting from exposure to lead in target housing paint, soil and dust were derived primarily from the blood lead distributions obtained for each of the categories of residential units. The method used to obtain these estimates is essentially identical to the methods previously used by EPA for estimating baseline health effects and benefits for regulating lead in gasoline and drinking water.

The adverse health effects included for children in this risk analysis are the effects on intelligence. Specifically, the effects on intelligence included in the analysis are:

- IQ point decrements
- Incidence of IQ less than 70
- Low level cognitive damage, estimated from the incidence of blood lead levels greater than 25 µg/dL.

The incidence of each of these adverse effects was estimated separately for the annual cohort of children in each of the housing groups, with the total for all children in that year's cohort obtained by summing across all subgroups. Again, the blood lead distribution for each of these subgroups was defined by the GM obtained from the IEUBK model and the assumed GSD of 1.6.

IQ Point Decrements The estimate of IQ point losses was obtained using a dose-response relationship of 0.25 points lost per µg/dL of blood lead, as provided by Schwartz (1993). To estimate the total IQ points lost among all children associated with a particular housing group, the 0.25 value was multiplied by the estimated arithmetic mean (or expected value) of the blood lead distribution and the number of children in that strata. Note that the value obtained from the IEUBK model is the geometric mean for that distribution, not the arithmetic mean. To adjust for this, the relationship between the expected value and the geometric mean of a lognormal distribution was used:

$$E(X) = \exp[\ln(GM) + (\ln(GSD)^2/2)]$$

where E(X) is the expected value (mean) of the distribution. Taking the log of both sides gives:

$$\ln(E(X)) = \ln(GM) * \ln(GSD)^2/2$$

Rearranging and monotonically transforming both sides of the equation into the natural exponential function gives the ratio between the mean and the GM of:

$$E(X) / GM = \exp((GSD)^2/2$$

For a GSD of 1.6, the resulting ratio between E(X) and GM is 1.117. Therefore, the total lost IQ points for each group was estimated as:

$$\text{LOST IQ} = \Delta GM * 0.25 * (Pop)_k * 1.117$$

where $(Pop)_k$ is the number of children in the kth group of dwellings. Thus if a group of residential units has 10,000 children and an estimated GM from the IEUBK model of 4 µg/dL, the estimated IQ points lost among these children due to lead is 11,170.

Incidence of IQ less than 70 The estimated incidence of IQ values below 70 was derived using the blood lead distributions for each housing strata in a similar manner. Standardized estimates are first made of the expected incidence of IQ less than 70, per unit population, for blood lead distributions having geometric means ranging from 0.5 up to 50 µg/dL (in 0.5 µg/dL increments), each with a constant geometric standard deviation of 1.6. For a given housing group with a particular GM predicted from the IEUBK, the incidence of IQ less than 70 is calculated simply as the unit value of IQ less than 70 obtained from the standardized estimates for a distribution with that GM, multiplied by the number of children associated with that housing group.

Blood Lead Levels greater than 25 µg/dL The estimate of children having blood lead levels above 25 µg/dL, which is used as a surrogate indicator of the need for compensatory education due to low-level cognitive damage, is derived directly from the blood lead distributions for each strata using the normal distribution function with the estimated geometric mean obtained from the IEUBK model and the assumed geometric standard deviation of 1.6. The probability of exceeding 25 µg/dL obtained from the normal distribution function for a given subgroup of units is then applied to the total number of children in that subgroup. The total number of children above 25 µg/dL is then obtained by adding the estimates across all housing subgroups.

6.2.5 Extrapolation of First Model Year Results to Full Modeling Time Frame

As discussed previously, the risk assessment modeling was premised on the assumption that presence of lead in paint, soil, and dust in dwellings in the private housing stock will continue to affect children born into those dwellings over many decades. In the preceding sections, the description of the modeling methodology used to estimate the incidence of adverse health effects resulting from lead in paint, soil, and dust focused on a single year's cohort, specifically that of the first benefit's model year (1998).

Existing residential units are assumed to disappear from the housing stock at rate of 0.5 percent per year. While this factor is assumed the same for all types of units, the effect in this model is to reduce the proportion of lead-based paint residential units relative to the total over the modeling period. Over the 50 year period, with an annual loss rate of 0.5 percent, the 74.2 million target housing units in 1998 would decrease to about 58 million ($74.2 * 0.995^{50}$). At the same time, the total occupied privately owned housing stock in 2047 is estimated to have increased to a total of 142.4 million. Therefore, in 2047, the final year of the modeling time frame, houses that had either interior or exterior lead-based paint in 1998 are estimated to comprise only 41 percent of the total. Note that by the end of the 50 years that are modelled, there are still houses remaining with lead-based paint (some in poor condition) that has not been abated.

The modeling of these temporal changes in the housing stock size, proportion of lead-based paint housing, and birth rates could be done by "brute force," iterating through each of the 50 years of the model time frame to calculate the incidence separately in each year, and then sum across all years to arrive at the total. A computational shortcut was used, however, taking advantage of the fact that children born into any one of the housing categories will have the same predicted blood lead distribution regardless of the year in which those children are born. The number of children to whom that distribution applies will vary from year to year according to the size of the housing stock and the birth rate. However, the blood lead distribution for children in that category of dwellings will remain the same.

6.2.6 Valuing Changes in IQ

The effect of lead on infants' and children's intelligence is described in Chapter 3. The dose-response functions in Chapter 3 are used to estimate the loss of IQ due to lead exposure from paint. The value of the IQ losses is calculated using procedures previously used in other EPA studies. Available economic research provides little empirical data for society's willingness to pay (WTP) to avoid a decrease in an infant's or child's IQ. As an alternative measure, it was assumed that IQ deficits incurred through lead exposure will persist throughout the exposed infant's lifetime. Two consequences of this IQ decrement, representing a portion of society's full willingness to pay, are then considered: the decreased present value of expected lifetime earnings for the infant and child, and the increased educational resources expended for a child who becomes mentally handicapped or is in need of compensatory education as a consequence of lead exposure.

Only the value of lost wages is considered in this analysis, underestimating the total value of avoiding loss of intelligence. Clearly other factors, including parental concerns over their children's futures, also are additional components of the total value of intelligence losses.

A reduction in IQ has a direct and indirect effect on earnings. The direct effect is straightforward — lower IQs decrease job attainment and performance. Reduced IQ also results in reduced educational attainment, which, in turn, affects earnings and labor force participation. Note that these effects on earnings are additive since the studies used for this analysis have controlled for these effects separately.

The probable link between reduction in lead exposure and increases in lifetime earnings had been established by two independent strands of research. First, medical research has shown that exposing young children to lead damages the brain and the rest of the nervous system, resulting in a reduction in ability as measured by an IQ test. Second, other research by labor economists has shown that IQ test scores are positively related to earnings, presumably because the IQ test measures ability.

The first step in this analysis is to estimate the present value of the earnings stream of an average newborn. Assume that, at any given age, this child will receive annual earnings equal in real terms to average earnings currently received by persons of the same age. This projected annual earnings stream is adjusted to take three other factors into account. First, assume some real increase in earnings will occur through general increases in productivity over time. Second, projected earnings are lowered to take into account probabilities of survival. Third, this lifetime earnings stream is expressed in present value terms by applying an appropriate discount rate.

The second step is to use the available empirical literature on the association between IQ and earnings to estimate the percentage increase in lifetime earnings one would expect from a one point increase in IQ. The approach assumes that changes in ability, as measured by an IQ test, alter earnings through two channels. First, changes in ability change earnings, holding constant the level of formal education one has achieved: more able college graduates earn more than less able college graduates, and so on. Second, changes in ability change years of schooling, which in turn alters the expected level of earnings: for example, more able students are more likely to complete college, which then leads to higher income.

Calculating earnings of an average person age 18-64 in 1992. This section explains the estimation procedure for the average earnings for persons age 18-64 in 1992. The next section uses these averages to project future earnings over the working life of persons born now, applying appropriate survival rates, productivity increases, and discount rates.

Information on annual earnings of persons in 1992 comes from *Money Income of Households, Families, and Persons in the United States: 1992*, (U.S. Department of Commerce, Bureau of the Census, Current Population Reports: Consumer Income, Series P60-184.) This report summarizes data obtained through the March, 1993 Current Population Survey. Tables from this source provide the following data by gender, age, and education groups:

- Average annual earnings for those with earnings
- Total number of persons with earnings
- Total number of persons

These three statistics are used to estimate average earnings for all persons, with or without earnings, by multiplying earnings for those with earnings by the fraction of persons with earnings.

These three statistics are generally reported by gender and for specific age groups, such as:

- 18-24 year-olds
- Five-year age groups: 25-29, 30-34, ..., 60-64
- Ten-year age groups: 25-34, 35-44, ..., 55-64

Within these age and gender groups, these same three statistics are typically reported for the following education groups:

- less than 9th grade
- 9-12th grade without a diploma
- high school graduate
- some college with no degree
- associate degree
- bachelor's degree
- master's degree
- professional degree
- doctorate

This information can be used to estimate average annual earnings for all persons — employed and not employed — in each gender/age/education group.

Average earnings are computed for those in a particular age group as a weighted average of the average earnings in each gender and education group in this age group. In this calculation, the weights are the shares of each group in each gender and education group.

A few assumptions were necessary to overcome some minor gaps in the information provided by the Census report.

First, the analysis uses estimates of earnings and employment rates for a combined sample of those with professional degrees and doctorates. In many instances, the Census Bureau determined that the sample size of these persons was too small to calculate separate figures for each of these two groups. Because the Current Population Survey (CPS) provides earnings and population counts for all those with at least a BA, for BA's alone, and for MA's alone, these data can be used to estimate earnings and employment rates for the combined sample of those with professional degrees and doctorates.

Second, the tables in the CPS report provide total counts of all persons in 10-year age groups (25-34, etc), but they provide earnings for those with earnings — and counts of those with earnings — in 5-year age groups (25-29, 30-34, etc). As a result, it is possible to directly estimate employment rates for 10-year groups, but not 5-year groups. Therefore, the analysis assumes that employment rates within 5-year age groups were both equal to employment rates within the relevant 10-year age group. For example, the employment rates for the 25-29 and 30-34 age groups were assumed to equal the employment rate for the 25-34 age group.

Third, the CPS tables did not provide total numbers of persons — and thus employment rates — for each education group in the 18-24 age group. The CPS tables provided only a total population for men and for women. The analysis assumes that the employment rate within each education group of 18-24 year olds was equal to the overall employment rate for 18-24 year olds, a figure available for both men and women.

Fourth, it is necessary to make certain assumptions about the educational attainment of those born today as they reach age 50 and above. For younger ages, assume the distribution of educational attainment for those born in 1992 is the same as the current distribution. When those born in 1992 reach ages 25-29, for example, assume they will have the same distribution as those aged 25-29 in 1992. When those born in 1992 reach their 50's and 60's, however, it may be less sensible to assume they will have the same distribution as those in their 50's and 60's today. Because average years of schooling have tended to rise over this century, older people often have fewer average years of schooling than younger people within any calendar year. Assuming those born in 1992 will have the same distribution at any age as the current 1992 population, is effectively assuming that people would lose years of schooling as they grow older.

Consequently, the analysis adopted the assumption that the distribution of educational attainment of those born in 1992 will be the same as the current distribution until those born in 1992 are older than age 49; after that age, the assumed educational distribution is fixed at the distribution of those aged 45-49 in 1992. In older age brackets in the 1992 distribution, educational attainment begins to decline. Using this slightly modified distribution of educational achievement, the analysis estimates the average earnings for all persons in these older age groups.

With these assumptions, it is possible to estimate average earnings for persons in the 18-24 year age group, and in each 5-year age group from 25-29 through 60-64.

Calculating the present value of lifetime earnings of a person born in 1992. The next step is to obtain the present value of lifetime earnings. The current average earnings by age are used to predict future annual earnings over the lifetimes of those born now. Appropriate survival rates, productivity increases, and discount rates are then applied.

When a person born now reaches age n, the predicted average annual earnings is the average for the corresponding age group. In other words, when a person born today reaches age 25, 26, 27, 28, and 29, assume this person's annual earnings will equal the average for the 25-29 age group.

Average future earnings at any age are reduced to the extent that some born now will not survive long enough to reach that age. The *Statistical Abstract of the United States* provides survival probabilities — the probability that someone alive at the start of age (n) will die before reaching age (n+1). With this information, it is possible to estimate the probability that someone born today survives through the end of the (n)th year of his or her life. As one might expect, the survival probability falls as a person ages, and is equal to the product of 2 probabilities:

1. The probability that a person alive at the start of that age year dies sometime in that age year (This figure is provided by the *Statistical Abstract of the United States*)

2. The probability that a newborn survives to the start of that year. (This figure can be estimated, based on the other probabilities).

The probability that a person will be alive at the start and at the end of each age year is averaged to estimate the probability that a person remains alive halfway through that age year. Multiplying the average predicted earnings by this final probability yields future earnings, adjusted for the probability of survival.

For many reasons, the nation's productivity, or output per capita, will tend to rise over time. The nation's capital stock increases. Technological innovations will probably continue to raise productivity. New generations will have more skills. At least some of this gradual increase in productivity will appear as an increase in real earnings. This analysis assumes that real earnings will increase by one percent per year.

The value of future earnings are discounted to obtain their present value. The assumed discount rate depends on interest rates on assets and on prevailing rates of time preference.

The formula used to estimate the present value of average earnings at age A, for a person born in 1992, is thus the following:

$$PV_A = \sum_{N=A}^{64} Y_N\, P_N (1+X)^{N-A+0.5} / ((1+r)^{N-A+1})$$

where:

A	=	current age, such as 0 for a person born now.
N	=	age of person in the future; an integer from A through 64
PV	=	present value of the total sum of earnings received between a given age
Y	=	average annual earnings for a particular age, as estimated in the manner explained above
P	=	survival probabilities, explained above
X	=	assumed annual increase in earnings due to rising productivity. Assumes productivity growth to the midpoint of age N.
r	=	rate of discount, for the beginning of age N.

Direct Effect of IQ on Wage Rate Aaron, Griliches, and Taubman have reviewed the literature examining the relationship between IQ and lifetime earnings (USEPA 1984). They find that the direct effect, (schooling held constant) of IQ on wage rates ranged from 0.2 percent to 0.75 percent per IQ point. Perhaps the best of these studies is Griliches (1977). He finds that the direct effect of IQ on wage rates to be slightly more than 0.5 percent per IQ point. Because this is roughly the median estimate of the EPA review (USEPA, 1984) of the literature, this estimate is used.

Indirect Effects of IQ on Earnings From Needleman et al. (1990) it is possible to estimate the change in years of schooling attained per one IQ point change. Their regression coefficients for the effect of tooth lead on achieved grade provide an estimate of current grade achieved. However, many of these children were in college at the time and are expected to achieve a higher grade level. Following Schwartz (1990a), after adjusting the published results for the fact that a higher percentage of children with low tooth lead were attending college. Schwartz estimated an expected 0.59 year difference in maximum educational grade achieved between the high and low exposure groups. Educational attainment is assumed to be linearly related to blood lead levels in proportion to IQ. The difference in IQ score between the high and low exposure group in the Schwartz analysis was 4.5 points. By dividing .59/4.5 = 0.131, the increase in lead exposure which reduces IQ by one point is also estimated to reduce educational attainment by 0.131 years.

Studies that estimate the relationship between educational attainment and wage rates (while controlling for IQ and other factors) are less common. Chamberlain and Griliches (1977) estimate that a one year increase in schooling would increase annual wages by 6.4 percent. In a longitudinal study of 799 subjects over 8 years, Ashenfelter and Ham (1979) reported that an extra year of education increased the average annual wage rate over the period by 8.8 percent. Conservatively, EPA used a lower bound estimate in previous analyses of the effects of lead by assuming one year of additional schooling increases the wage rate by 6 percent. The EPA assumption is used in the current analysis. To arrive at the indirect effect of increased schooling, the percentage increase in wages (lifetime) per IQ point is calculated using: (6 percent wage increase/school year) x (0.131 school years/IQ) = 0.786 percent increase in wages per IQ point.

There is one final indirect effect on earnings. Changes in IQ affect labor force participation. Failure to graduate from high school, for example, correlates with participation in the labor force, principally through higher unemployment rates and earlier retirement ages. Lead is also a strong correlate with attention span deficits, which likely reduce labor force participation. The results of Needleman et al. (1990) relating lead to failure to graduate from high school can be used to estimate changes in earnings due to labor force participation. Using the odds ratio from Needleman et al., it was estimated that a one IQ point deficit would also result in a 4.5 percent increase in the risk of failing to graduate. Krupnick and Cropper (1989) provide estimates of labor force participation between high school graduates and non-graduates, controlling for age, marital status, children, race, region, and other socioeconomic status factors. Based on their data, average participation in the labor force is reduced by 10.6 percent for persons failing to graduate from high school. Because labor force participation is only one component of lifetime earnings (i.e., earnings = wage rate X years of work), this indirect effect of schooling is additive to the effect on wage rates. When this estimate is combined with the Needleman result of a 4.5 percent increase in the risk of failing to graduate from high school per IQ point, the result indicates that the mean impact of one IQ point loss is a (10.6 percent x 4.5 percent =) 0.477 percent decrease in expected earnings from reduced labor force participation.

Combining the direct effect of 0.5 percent with the two indirect effects (0.786 percent for less schooling and 0.477 percent for reduced labor force participation) yields a total of 1.76 percent decrease in earnings for every loss of one IQ point.

Value of Foregone Earnings To monetize effects of reduced intelligence on earnings, the percent earnings loss estimate must be combined with the estimate of the present value of expected lifetime earnings. The earnings estimates described above were calculated assuming a one percent real wage growth and a three percent discount rate.

The estimate of the increase in lifetime earnings arising from a single point increase in IQ score is clearly sensitive to the discount rate chosen. Because this analysis measures the association between earnings and IQ test score as a simple, constant, linear relationship, the value of an IQ point is directly proportional to the value of lifetime earnings. As the discount rate rises, both the value of lifetime earnings and the value of an IQ point fall.

To gauge the sensitivity of the value of an IQ point to the selection of a discount rate, alternative estimates of the value of an IQ point using a range of discount rates are presented. As Exhibit 6.3 shows, the estimated value of an IQ point varies substantially as the discount rate changes. The value is $6,442 at a 3 percent discount rate, but only $1,480 at a 7 percent discount rate. The range of estimates grows even larger under more extreme discount rate assumptions: the value of an IQ point is $23,049 at a 0 percent discount rate, but only $568 at a 10 percent discount rate.

Exhibit 6.3: Estimated Value of an IQ Point under a Range of Assumed Discount Rates

Assumed Discount Rate	Estimated Value of an IQ Point, in Terms of the Present Value of Lifetime Earnings
0	$23,049
3	$6,442
5	$2,995
7	$1,480
10	$568

Increased Educational Resources There are two categories of increased educational resources needed as a result of lead exposure. First, lead exposure results in an increase in the number of infants with IQs less than 70 (note that IQ is not measured until age 7). As these infants grow older, they will need an education program tailored to the mentally handicapped. In addition, some infants whose blood lead is greater than 25 µg/dL will need additional instruction while attending school later in life.

Infants with IQs Less than 70 To value the reduction in the number of infants with IQs less than 70, the reduction in education costs was measured — a clear underestimate of the total benefits. The largest part of the omitted benefits is parents' willingness to pay to avoid having their child become mentally handicapped. Kakalik et al. (1981), using data from a study prepared for the Department of Education's Office of Special Education Programs, estimated that part-time special education costs for children who remained in regular classrooms cost $3,064 extra per child per year in 1978. Adjusting for changes in the GDP price deflator yields an estimate of $6,935 per child in 1993 dollars. For the calculations, this incremental estimate of the cost of part-time special education was used to estimate the cost per year per child needing special education as a result of impacts of lead on mental development. Costs would be incurred from grades 1 through 12. Discounting future expenses at a rate of 3 percent yields an expected present value cost of approximately $57,809 per infant (assuming compensatory education begins at age 7 and continues through age 18). Note that this may underestimate the cost, since no children are assumed to be educated in facilities solely dedicated to special needs students.

Preventing Low-Level Cognitive Damage For this analysis it is assumed that 20 percent of the children with blood lead levels greater than 25 µg/dL will require compensatory education for three years. Because the number of cases avoided in this category is estimated to be negligible, the annual compensatory education cost savings associated with the these infants are not calculated.

6.2.7 Infant and Children Benefit Estimates

The average benefits to infants and children from completely abating housing units with interior paint lead content greater than 1 mg/cm^2 and in deteriorated condition, or in good condition on friction surfaces, or soil levels greater than 5,000 ppm, are about $9,000. This includes benefits accruing to not only the current resident children, but also potential future residents that may occupy the abated unit at some time during the next 50 years. The benefits estimate is a weighted average of benefits for houses that need only paint abatement, houses that need only soil abatements, and houses that need both. The average benefits of a target housing abatement is shown on Exhibit 6.4, along with the total benefits for abatements occurring in the second year that the rule is in effect (first year benefits accrue), and the present value of all residences abated in 49 years (2.7 million units).

Exhibit 6.4: Monetary Benefits to Children of Target Housing Abatements*

Target Housing Abatements	Benefits Per Abatement	Present Value of Benefits from Abatements Performed in the Second Year Rule Is In Effect** (Millions)	Present Value of Benefits from 49 years of Abatements (Millions)
	$9,181	$500	$13,100

* Total measured benefits of abatements, including incremental benefits from §§402(a) & 404. Measured monetary benefits are from value of IQ loss and cost of compensatory education.
** These are the present value of the stream of benefits accruing because of abatements in a single year.

The children's health effects associated with pica are potentially very important, due to the much larger intake of lead. There is considerable uncertainty in modelling the effects of pica. The IEUBK Guidance Manual recommends that pica uptake be modelled cautiously, and that the results of pica ingestion have greater uncertainties than exposure from other media (i.e., dust).

However, only 2.4 percent the housing units with lead-based paint in bad condition are assumed to have children who exhibit pica (and hence only 2.4 percent of the children). The small assumed net incidence of pica reduces the impact of pica on the overall benefits assessment. If the pica prevalence assumption is set to zero (or any other pica-related assumption in the analysis changed to equivalently eliminate estimating pica-related benefits), the average benefits per abated housing unit is $8,017. Thus the 2.4 percent of all children who are modelled as ingesting paint chips account for nearly 13 percent of the benefits. Pica also would contribute 13 percent of the first year benefits and of the present value of the 49 years of abatements.

6.3 Child-Occupied Facilities

In addition to lead-based activities in target housing, the training and work practice standards required by §§402(a) and 404 will also apply to lead-based paint activities performed in child-occupied facilities (COFs). Because of the large number of children typically found in these locations each year, there is potential for accruing significant economic benefits due to properly conducted abatements. This analysis focuses on COFs located in buildings other than residences.

While the potential economic benefits of abating COF may be large, less information is available about the health impacts of abating these locations than about the impact of abating housing units. The analysis of the benefits potentially accruing to children from abating lead in housing units is based on the modeled impacts of children exposed to lead-based paint while living in the houses up to the age of seven. The impact of the target housing exposure also reflects that children spend much of their time in the house, during which their activity levels ranges from active play to sleep. Any attempted analysis of the impacts of abating COF are complicated by the fact that children are only in these buildings part of the time. However, because of the potential importance of abating COF, an economic analysis of the benefits is presented in this section.

The COF analysis is based on the housing analysis, with additional assumptions described below made to reflect some of the important differences between the exposure pattern in COF and in residential units. The analytical results are necessarily less certain than the benefits associated with target housing abatements. Like the estimated benefits of abating housing, only the total benefits of abating COF are developed; it is impossible to identify the incremental benefits of the §§402(a) and 404 requirements. Hence only some portion of the estimated benefits will be attributable to this rule.

The following assumptions are used to adjust the results of the housing benefits analysis to model the COF abatements. Each assumption is discussed, and some potential biases and uncertainties are noted.

- The distribution of lead-based paint hazards (lead-based paint and lead in soil) for lead-contaminated COF is assumed identical to the distribution in housing units. The HUD 1991 survey of housing units is again used as the basis for this analysis, including the joint distribution of XRF levels, lead content of dust, soil lead levels, and the HUD-derived weights used to extrapolate from a sample of 284 dwellings to the national population. The actual distribution of paint, soil, dust and paint condition in schools may differ from that in housing units.

- In-home day care (including both registered and informal arrangements) and home schooling are not included in the COF analysis. In-home arrangements are assumed to be captured by the target housing analysis. This will result in the in-home day care and school benefits being underestimated due to more children being exposed to lead-based paint in an in-home day care setting than typically live in a residence.

- A COF is a candidate for an abatement if any of three conditions are present: lead-based paint in bad condition; lead-based paint in good condition but on friction surfaces, soil lead levels greater than or equal to 5,000 ppm. These are the same basic eligibility conditions assumed for target housing abatements. However, the target housing abatement analysis assumed a more stringent requirement concerning lead-based paint on friction surfaces; a child must be present at the time the abatement decision is made. This assumption effectively reduces the probability that a target housing abatement would occur because of lead paint on friction surfaces. Because children will definitely be present in a COF, the more stringent assumption is not relevant in the COF analysis. Several states already require that any lead paint in schools be abated, regardless of condition. Assuming that paint condition or friction surfaces are not relevant would lower the per-unit abatement benefits (as paint in good condition generally results in smaller increases in blood lead levels), but also to increase the number of COF that require abating.

- There are 62 children in each school every year (from "The Demand and Supply of Child Care in 1990" (1991)). The target housing analysis assumed the birth rate over the 50 year analysis averages 0.0353 births per residence per year. This effectively means the target housing analysis assumed there are 0.0353 newborns per housing unit. Thus COF are assumed to be attended by (62/0.0353) more children than the average residence.

- The lead exposure for the 62 children modelled as attending each COF is assumed to be the only lead-based paint exposure for these children. However, some of these children will be living in housing with lead-based paint, and would be already included in the previous target housing analysis. The COF analysis assumes that the facility exposure to additional lead-based paint exposure for these "twice-exposed" children is in addition to the target housing exposure. If the combined effects of the dual exposures were expressly modelled, the total effects for these children would be greater due to the non-linear and increasing nature of the concentration-response functions. Thus the COF analysis could be an underestimate of the total benefits. However, it is also possible that the effects of the school exposures are implicitly captured in the distribution of blood lead levels and uptake assumptions in the IEUBK model. If so, the COF analysis would overestimate the benefits by double-counting children exposed both at home and at the COF.

- The effect of part-time exposure to lead-based paint conditions that occurs in schools is assumed to be linearly proportional to the effect of living in a housing unit with identical conditions. For example, if a child is inside a school building only one tenth the amount of time they would occupy a housing unit, the health impact is assumed to be one tenth as much. The following assumptions are used to adjust the housing exposures for use in COF:

  (1) Each child receives one exposure-year for each year they attend COF at a center with lead-based paint. The target housing exposure analysis assumes that the exposure occurred through age six. Following the "linearity-in-exposure" assumption, the target housing analysis is multiplied by one seventh to estimate the effects of one year of exposure. Thus 62 children in a COF in a single year results in 62 COF exposure-years. The following year another 62 COF exposure-years occur, but not necessarily to the same children.

  (2) Children are only in the COF half the days in the year (due to weekends, federal and school holidays, family vacations, and illness), so each exposure year is reduced by one-half.

  (3) Children are only in the COF half their waking hours, and lead uptake from exposure to lead-based paint conditions is assumed to occur during waking hours only. Therefore, this one-half exposure year is further reduced by one-half.

  These three factors combine to estimate the health effects for a child less than seven years old attending one year in a COF with lead-based paint are only one twenty-eighth (0.0357 = .5*.5*(1/7)) as great as the health effects of living in a housing unit with similar paint characteristics through age six.

The combined result of these assumptions is that abating COF yields considerably more benefits per abatement (62.7 times as much, from 62.7=62/.0353 × .0357) than abating target housing units. However, because only one hundredth as many COF abatements occur (500 per year) as target housing abatements (55,045 per year), the benefits from abating residences is larger than for abating COF. As the number of both target housing and COF abatements remains constant in each year, the total present value of the 49-year stream of abatements is also larger for target housing abatements than for COF abatements. The results of the COF benefits analysis are shown on Exhibit 6.5. Benefits are assumed to start in the second year that the rule is in effect, after both the training and work practice standards are in effect.

Exhibit 6.5: Monetary Benefits to Children from Child Occupied Facility Abatements*

Child Occupied Facility (COF) Abatements	Benefits Per Abatement (Thousands)	Present Value of Benefits from Abatements Performed in the Second Year Rule is in Effect** (Millions)	Present Value of Benefits from 49 Years of Abatements (Millions)
	$268	$127	$3,045

* Total measured benefits of abatements, including incremental benefits from §§ 402, 404. Monetary benefits include value of IQ loss and compensatory education costs.
** These are the present value of the stream of benefits accruing because of abatements in a single year.

6.4. Summary of the Partial Benefits Estimation

It is not possible to quantify the benefits directly resulting from the §402(a) training and standards requirements because information on exposure changes caused strictly by the training and standards is not available. Sections 402(a) and 404 will not directly cause an increase in the amount of lead-based paint activities that will occur in the future, but may improve the future quality of the lead-based paint activities. The improved quality may result in decreased lead exposure, and hence decreased risk of the known and suspected health effects of lead, in the following categories:

- Exposure to residents of houses during, and immediately following, abatement due to the occupant protection plan and clean up of lead contaminated dust and debris from the abatement.

- Exposure to children attending COF during, and immediately following, abatement due to the occupant protection plan and clean up of lead contaminated dust and debris from the abatement.

- Long term lead exposure to current and future residents of abated units due to proper identification and permanent abatement of lead-based paint hazards in the dwelling.

- Long term lead exposure to current and future children attending abated COF and schools due to proper identification and permanent abatement of lead-based paint hazards.

- Occupational exposure to inspectors, risk assessors, and abatement workers from training in, and adherence to, work practice standards for inspection, assessment, and abatement procedures.

- Exposure to other people who live, work or travel near to abatement activities due to abatement activities being performed by trained workers following the work practice standards.

- Ecological damage from lead exposure from abatements due to the work practice standards including proper containment and clean-up requirements.

An alternative approach that has been developed in this chapter is to attempt to get a rough idea of the potential magnitude of the problem by estimating the quantifiable benefits that accrue to residents from conducting a target housing abatement. Quantified benefits per target housing abatement have been estimated for only one category of health effects: medical cost and intelligence effects in infants and children. Appendix 6.A summarizes the range of potential health benefits with an indication of the per unit valuation and basis for each estimate. The benefits in infants and children in residences have the best information base. The change in children's blood lead levels are estimated using an approach based on HUD data and the IEUBK lead uptake model. The health effects and valuation estimates in infants and children rely on well established methods previously used by EPA.

The neurological benefits to children attending COF (for children through age six) were estimated from the basis of the target housing analysis. The information base to support this analysis is not as strong. The analysis required making additional assumptions about the effect of exposure at COF only occurring during the time that children are present.

One other benefit category is developed as part of the sensitivity analysis in Chapter 7: neonatal mortality. While more information is available on this benefit category than on other unquantified benefit categories, there is sufficient missing information to prevent its inclusion in the primary benefit analysis. The crucial missing information is the change in maternal blood lead levels that will occur due to abatements.

A summary of the benefits estimates is shown on Exhibit 6.6. Note once again that the reported benefits are the estimated values for some, but not all, of the benefits of performing abatements, not the benefits directly attributable to the rule.

Exhibit 6.6 Summary of Total Measured Monetary Benefits*

Benefit Category	Present Value of Benefits from Abatements Performed in the Second Year Rule Is In Effect** (Millions)	Present Value of Benefits from 49 Years of Abatements (Millions)†
Children in Target Housing	$499	$13,100
Children in Child-Occupied Facilities	$126	$3,000
Total Measured Benefits of Abatements Affected by §§402(a) and 404	$625	$16,100

* Total measured benefits, including incremental benefits from §§402 and 404.
Benefits are from value of IQ loss and cost of compensatory education.

** These are the present value of the stream of benefits accruing because of abatements in a single year.

† Benefits discounted at three percent for abatements occurring during 1998 through 2047.

Appendix 6.A: Section 402/404 Per Unit Valuations used in Benefits Estimation

Health Hazard Category	Per unit value	Basis for estimate	Qualifications
<u>Infants < 1 Year old</u>			
Neonatal mortality from decreased gestational age (Chapter 7, sensitivity analysis)	$5.5 million/death	Based on a range of values taken from hedonic wage studies and/or contingent valuation studies of primarily middle aged adults.	Possible underestimate. Willingness-to-pay values are likely to be higher for infants compared to adults.
Fetal effects from maternal exposure, including diminished childhood IQ and reduced birth weight	-	There is insufficient information available to perform an exposure analysis which would estimate a quantified relationship between the presence of lead-based paint and/or lead contaminated soil and the fetal effects from maternal lead exposure.	Reduced birth weight concerns relate to neonatal mortality and diminished IQ relates to concerns of reduced intelligence, both of which are estimated within the analysis.
Reduced intelligence from first year post-natal exposure (Chapter 6, Benefits of the Regulation)	$6,442/IQ point (discounted at 3%)	Based upon the discounted value of life-time earning streams.	Possible underestimate because willingness-to-pay to avoid reduced IQ levels may exceed life-time earning streams. Other factors, including parental concerns over their children's future, are not factored into the total value of intelligence losses.

Health Hazard Category	Per unit value	Basis for estimate	Qualifications
Other neurological and metabolic effects	-	This item was not estimated because of a lack of per unit valuation. In addition, there is insufficient information available to perform an exposure analysis which would estimate a quantified relationship between the presence of lead-based paint and/or lead contaminated soil and neurological and metabolic effects in children.	Clear underestimate. To the extent that lead exposure results in behavioral problems such as hyperactivity, behavioral and attentional difficulties, delayed mental development, and motor and perceptual skill deficits, potential benefits will be underestimated.
<u>Children < 7 Years Old</u>			
Interference with growth	-	This item was not estimated because of a lack of per unit valuation. In addition, there is insufficient information available to perform an exposure analysis which would estimate a quantified relationship between the presence of lead-based paint and/or lead contaminated soil and abnormal growth in children.	Clear underestimate.
Reduced intelligence (Chapter 6, Benefits of the Regulation)	$6,442/IQ point (discounted at 3%)	Based upon the discounted value of life-time earning streams.	Possible underestimate because willingness-to-pay to avoid reduced IQ levels may exceed life-time earning streams. Other factors, including parental concerns over their children's future, are not factored into the total value of intelligence losses.

Health Hazard Category	Per unit value	Basis for estimate	Qualifications
Impaired hearing, behavioral changes	-	This item was not estimated because of a lack of per unit valuation. In addition, there is insufficient information available to perform an exposure analysis which would estimate a quantified relationship between the presence of lead-based paint and/or lead contaminated soil and impaired hearing in children.	Clear underestimate
Interference with nervous system development	-	This item was not estimated because of a lack of per unit valuation. In addition, there is insufficient information available to perform an exposure analysis which would estimate a quantified relationship between the presence of lead-based paint and/or lead contaminated soil and abnormal nervous system development in children.	Clear underestimate
Metabolic effects, impaired heme synthesis, anemia	-	This item was not estimated because of a lack of per unit valuation. In addition, there is insufficient information available to perform an exposure analysis which would estimate a quantified relationship between the presence of lead-based paint and/or lead contaminated soil and metabolic effects in children.	Clear underestimate

Health Hazard Category	Per unit value	Basis for estimate	Qualifications
Possible Cancer	-	Although this item could be valued, there is insufficient information available to perform an exposure analysis which would estimate a quantified relationship between the presence of lead-based paint and/or lead contaminated soil and possible cancer effects in children.	Clear underestimate.
<u>Adult Men</u>			
Hypertension (Chapter 7, sensitivity analysis)	$767/case	This value is based upon an estimate of the annual direct medical costs of hypertension (including physician charges, medication costs, hospitalization costs and lost work time).	Possible underestimate. The cost of illness approach does not account for pain and suffering due to illness, the value of lost leisure time, or the role of preventive expenditures. Therefore, cost of illness estimates most likely underestimate total costs to society.
Non-fatal heart attack and non-fatal stroke in adults (Chapter 7, sensitivity analysis)	$1.76 million/case	This value is based upon studies of the willingness-to-pay to avoid a statistical case of chronic bronchitis.	Direction of bias unknown. No willingness-to-pay studies were found that were specific to non-fatal heart attacks and strokes.

Health Hazard Category	Per unit value	Basis for estimate	Qualifications
Premature death from all causes in adults (Chapter 7, sensitivity analysis)	$5.5 million/death	Based on a range of values taken from hedonic wage studies and/or contingent valuation studies of primarily middle aged adults.	Possible overestimate. Evidence suggests that willingness-to-pay values may be lower for older adults. Therefore, to the extent that the hedonic wage studies and contingent valuation studies used for this analysis are based on middle-aged adults, values may be overestimated for older adults. Two countervailing theoretical arguments have been put forth in the literature: 1) The relative remaining life span of an older adult is shorter than that of a middle-aged adult and therefore less valued; and 2) In general, older adults exhibit more risk averse behavior which may suggest a higher willingness-to-pay value.
Possible Cancer	-	Although this item could be valued, there is insufficient information available to perform an exposure analysis which would estimate a quantified relationship between the presence of lead-based paint and/or lead contaminated soil and possible cancer effects in adult men.	Clear underestimate.
<u>Adult Women</u>			
Hypertension (Chapter 7, sensitivity analysis)	$767/case	This value is based upon an estimate of the annual direct medical costs of hypertension (including physician charges, medication costs, hospitalization costs and lost work time).	Possible underestimate. The cost of illness approach does not account for pain and suffering due to illness, the value of lost leisure time, or the role of preventive expenditures. Therefore, cost of illness estimates most likely underestimate total costs to society.

Health Hazard Category	**Per unit value**	**Basis for estimate**	**Qualifications**
Non-fatal heart attack and non-fatal stroke (Chapter 7, sensitivity analysis)	$1.76 million/case	This value is based upon studies of the willingness-to-pay to avoid a statistical case of chronic bronchitis.	Direction of bias unknown. No willingness-to-pay studies were found that were specific to non-fatal heart attacks and strokes.
Premature death from all causes (Chapter 7, sensitivity analysis)	$5.5 million/death	Based on a range of values taken from hedonic wage studies and/or contingent valuation studies of primarily middle aged adults.	Possible overestimate. Evidence suggests that willingness-to-pay values may be lower for older adults. Therefore, to the extent that the hedonic wage studies and contingent valuation studies used for this analysis are based on middle-aged adults, values may be overestimated for older adults. Two countervailing theoretical arguments have been put forth in the literature: 1) The relative remaining life span of an older adult is shorter than that of a middle-aged adult and therefore less valued; and 2) In general, older adults exhibit more risk averse behavior which may suggest a higher willingness-to-pay value.
Reproductive effects	-	This item was not estimated because of lack of per unit valuation. In addition, there is insufficient information available to perform an exposure analysis which would estimate a quantified relationship between the presence of lead-based paint and/or lead contaminated soil and possible reproductive effects in women.	Clear underestimate. Potentially significant value on a per unit basis, however, no information is available on the frequency of such health effects.

Health Hazard Category	Per unit value	Basis for estimate	Qualifications
Possible Cancer	-	Although this item could be valued, there is insufficient information available to perform an exposure analysis which would estimate a quantified relationship between the presence of lead-based paint and/or lead contaminated soil and possible cancer effects in adult women.	Clear underestimate.

7. SENSITIVITY ANALYSIS

This chapter presents a series of sensitivity analyses that examine the variability of estimated benefits and costs as the values of key variables are changed. As described in Chapter 6, the benefit estimates exclude certain health effects because the information necessary for estimating these benefits is not available at this time. In addition, there is some uncertainty about the values assigned to certain key elements in the cost and benefit analyses, such as the number of lead-based paint abatement events and the number of people to be trained in certain disciplines.

To prevent the number of sensitivity analyses from becoming unwieldy, alternative analyses that involve relatively straight-forward relationships were not performed. For example, total costs would change more or less proportionately with uniform changes in the unit costs. In other cases, however, potential changes involve assumptions about relationships among elements in the estimations or assumptions about the rate at which events will occur. Since changes such as these will not necessarily affect the results in a straight-forward manner, they are the focus of the sensitivity analyses.

This chapter presents six sets of sensitivity analyses. Two sets affect the costs:

- Alternative work practice standards costs, resulting from alternative estimates of likely soil abatement practices;

- Alternative demand for training and thus training costs, resulting from alternative assumptions of likely workload.

Three sets of sensitivity analyses affect the benefits while leaving the costs unchanged. These include:

- Benefits from avoided neonatal mortality.

- Benefits from additional reductions in occupational exposure (beyond that provided by OSHA worker protection regulations).

- Benefits to adult residents.

In addition, one set of analyses affects both costs and benefits. This analysis uses an:

- Alternative discount rate of 7 percent, in place of the 3 percent social discount rate used in Chapters 5-6;

7.1 Alternative Costs of Standards (Soil Abatements)

Since performance standards constitute approximately 57 percent of total costs, changes in performance standards might have a substantial impact on costs. Soil abatement is one area where there is considerable uncertainty as to the amount of soil that the risk assessors will recommend removing. The work practice standard recommendations for soil abatement under this rule state that "the lead contaminated soil shall be removed to a depth determined by the risk assessor." Current industry practice is to remove soil to a depth of 2½ inches. The proposed rule, however, estimated costs for removing soil to a depth of 6 inches. Since this rule does not require specific standards for soil abatement procedures, this sensitivity analysis estimates the cost of removing 6 inches of soil as earlier proposed. As shown in Exhibit 7.1, increasing the soil depth removal to 6 inches increases the total 50-year discounted cost estimates for work practice standards by 46 percent and total costs of the rule by 26 percent. Although soil abatements constitute a small percentage of total abatements, the incremental cost of 6-inch soil removal is approximately $9,000, since the soil would need to be handled as a hazardous waste. A corresponding sensitivity analysis of removing less soil than the current common practice was not performed because work practice standards are not expected to decline under this regulation.

Exhibit 7.1: Changes in Incremental Costs Under Alternative Soil Depth Removal (Costs in $ millions)

	Total Discounted Costs	6" Soil Depth Removal Cost	% Change from Primary Analysis
Training	**$228**	**$228**	**0%**
Standards	**$637**	**$929**	**46%**
State Program Administration	**$249**	**$249**	**0%**
Total	**$1,114**	**$1,406**	**26%**

7.2 Alternative Demand for Training

Training requirements constitute about 20 percent of the total costs. Increasing the workload (i.e., jobs per year) of both inspectors and risk assessors would decrease the demand for trained persons in these disciplines. The current estimated workload for inspectors and risk assessors (46 jobs per year) is based on the assumption that these professionals would handle about one case a week. (In Massachusetts, an inspector performs only 23 lead-based paint inspections per year on average). Since 46 inspections, lead hazard screens, or risk assessments per year would not constitute full-time employment, a sensitivity analysis was performed, where the demand for training decreased because the average number of jobs performed per year was doubled. As shown in Exhibit 7.2, increasing the jobs per year to 92 for inspectors and risk assessors decreases the training costs by approximately 28 percent, and total costs by 5.8 percent over the 50-year period. This small reduction in total costs is a reflection of the relatively small proportion of total costs resulting from training. A corresponding sensitivity analysis of reducing work loads and increasing the number of people trained was not performed because there is already assumed to be an oversupply of trained staff in some disciplines; and in all cases, work load levels imply much less than full-time employment.

Exhibit 7.2: Changes in Incremental Costs Under Reduced Training Requirements: Decrease Demand for Inspector and Risk Assessor Training (Costs in $ millions)

		Reduced Training Requirements	
	Total Discounted Costs — Primary Analysis	Total Cost	% Change from Primary Analysis
Training	$228	$163	-28%
Standards	$637	$637	0%
State Programs	$249	$249	0%
Total	$1,114	$1,050	-6%

7.3 Neonatal Mortality

Previous EPA regulatory analysis of lead exposure has included neonatal mortality as a quantified effect. However, very limited information is available on the impact of lead paint on pregnant women. In addition, there is conflicting evidence from the scientific literature about whether elevated maternal blood lead levels contributes to increased incidence of neonatal mortality. There is inconsistent evidence that elevated maternal blood lead levels are related reduced birth weight and reduced gestational age (which are well correlated to increased incidence of mortality). In 1993 the ATSDR's *Toxicological Profile for Lead* concluded that "The weight of the evidence indicates that there may not be a direct association" between blood lead levels and reduced birth weight or gestational age.

Due to the limited information on the effect of abatements on pregnant women, and the uncertainty about the impact of increased blood lead levels, estimates of neonatal mortality are presented as a part of the sensitivity analysis, and not part of the primary quantified benefits. As shown below, this is a potentially significant benefit category. Even modest changes in maternal blood lead levels could have a pronounced effect on the monetary benefits estimates.

The possible magnitude of the monetary benefits associated with neonatal mortality are derived from the benefit analysis prepared by the Centers for Disease Control (1991) for abating lead-based paint in public housing. The CDC used the following assumptions:

- The risk of infant mortality decreases by 0.0001 for each 1 µg/dL reduction in maternal blood lead level (based on data from the Linked Birth and Infant Death Record Project of the National Center for Health Statistics and the effect of lead on gestational age from Dietrich et al. (1987)).

- Abatement prevents an increase of 2.13 µg/dL in the blood lead level of a pregnant woman (based on Cincinnati data from R. Bornschein).

The CDC assumptions on the risk factor and the decrease of blood lead levels are used as the basis of the current estimation. The first CDC assumption is the result of analysis based on medical and public health literature on the effects of lead on gestational age, and gestational age and neonatal mortality. The second assumption (about the blood lead levels of pregnant women living in housing units with lead-based paint), is less certain. While it is very likely that living in housing with lead-based paint hazards will increase the blood lead levels of pregnant women (documented evidence reviewed in Chapter 3 indicates blood lead levels increase for all adults living in such housing), there is considerable uncertainty about the magnitude of the increase in blood lead levels.

In order to estimate the neonatal mortality benefits of abating a single target housing unit, several additional assumptions must be made, including what value to place on a statistical life. In order to estimate benefits associated with regulations that are anticipated to reduce mortality, a dollar value must be associated with a "statistical life", or the estimated number of lives that will be saved. This is very different in concept from assigning a value to any individual life, which cannot be valued. There are several types of economic studies that have attempted to determine the value of a life. Of these, most use labor market data to determine workers' trade offs between wages and risk. In addition, some researchers have used contingent valuation to evaluate willingness to pay to avoid risk. Fisher et al. (1989) reviewed a large number of studies, with a range from $2 million to $11 million per statistical life (1986 values adjusted for inflation and real income growth to 1992 dollars), and recommended use of the entire range. The most recent review of the results of research using these approaches found a range of values from $700,000 to $16.2 million in 1990 dollars (Viscusi 1992). Based on Viscusi (1992) and other sources, EPA's Office of Indoor Air (1994) selected 26 studies and calculated their mean estimated value of life to be $5.5 million, with a standard deviation of $3.6 million (1994 dollars).[1]

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[1]EPA's Office of Indoor Air (1994) reported a value of life to be $4.8 million and standard deviation of $3.2 million in 1990 dollars. These values have been updated to 1994 dollars.

Other assumptions include the following:

- Abatement of a unit is assumed to produce benefits for 50 years (CDC uses 67 years).

- On average, there will be a pregnant woman living in 3.99 percent of the housing units (based on Census data; CDC used 4.5 percent). The probability of a housing unit having a live birth is assumed to be the same as the probability of a child less than one living in a house described above. Note that this assumption implies both that 3.99 percent of the units have a live birth living in them in any given year, and that over the 50 year remaining useful life of single unit, a newborn child will live in the unit 3.99 percent of the time.

- The present value of future monetary values are calculated using a 3 percent discount rate. (CDC used a 5 percent discount rate).

The estimated benefits of avoiding the risk of neonatal mortality by abating a housing unit occupied by a pregnant woman are:

$$\left(\frac{\textbf{.0001 deaths}}{\textbf{1 µg/dL}}\right) * \left(\frac{\textbf{2.13 µg/dL}}{\textbf{Pregnant Woman}}\right) * \left(\frac{\textbf{\$5.5 Million}}{\textbf{death}}\right) = \frac{\textbf{\$1,164}}{\textbf{PregnantWoman}}$$

Because there are pregnant women in only 3.99 percent of the housing units, the annual benefits for each unit equal:

$$\left(\frac{\textbf{.0399 Pregnant Women/year}}{\textbf{Housing Unit}}\right) * \left(\frac{\textbf{.0001 deaths}}{\textbf{1 µg/dL}}\right) * \left(\frac{\textbf{2.13 µg/dL}}{\textbf{Pregnant Woman}}\right) * \left(\frac{\textbf{\$5.5 Million}}{\textbf{death}}\right)$$

$$= \frac{\textbf{\$46.44/year}}{\textbf{Housing Unit}}$$

The total estimated benefits from avoiding neonatal mortality from each interior abatement equal the present value (discounted to the time of abatement using a discount rate of r=.03) of the 50 year assumed remaining life of the house:

$$\sum_{i=1}^{50} \left(\frac{\textbf{\$46.44/year}}{\textbf{Housing Unit}}\right) * \left(\frac{1}{1+r}\right)^{i} = \frac{\textbf{\$1,181}}{\textbf{Housing Unit}}$$

These neonatal benefit calculations are based on the CDC data of a 2.13 µg/dL change in the blood lead levels of pregnant women. Other blood lead changes can be readily estimated for other size changes because there is a linear relationship between the
size of the

assumed blood lead change and the size of the benefits. For example, if the blood lead level change is only half as large (1.065 μg/dL), the benefits are half as large.

The CDC data that is the basis of the pregnant woman blood lead change was limited to an analysis of paint conditions, and not soil conditions. Therefore, neonatal mortality benefits in the §402(a)/404 analysis are assumed to occur for each housing unit that has a paint abatement (whether a soil abatement is also done or not), but not for units that only have soil abatements. This lowers the neonatal benefits for an average abatement (including those with paint abatements and those without) to $1,163. The benefits of avoiding neonatal mortality are shown in Exhibit 7.3.

Exhibit 7.3: Estimated Neonatal Mortality Benefits of Complete Abatements (for a 2.13 ug/dL change in blood lead levels)*

Residential Abatements	Benefits Per Abatement	Present Value of Benefits from the First Year of Abatements (Millions)	Present Value of Benefits from 49 Years of Abatements (Millions)
	$1,163	$64	$1,538

* Total measured benefits of residential abatements, including the incremental benefits from §§ 402(a) & 404.

7.4 Worker Benefits

All personnel involved with lead paint activities (including inspectors, risk assessors, supervisors and workers) may receive benefits from §402(a) from decreasing their lead exposure due to the mandatory training, and from meeting the prescribed standards for lead paint activities. Quantifying the benefits that will accrue to all the workers is not possible at this time because there is very little information on how average worker blood lead levels will change when the training and standards are implemented. In order to estimate the benefits-per-worker, it would be necessary to estimate the geometric mean and standard deviation blood lead levels for the workers affected by the regulations at both baseline and post-regulation levels. However, some estimates of the size of the potential benefits can be calculated using an analysis prepared for the interim final lead exposure standard for construction workers. This regulation sets a Permissible Exposure Limit (PEL) for airborne lead from abatement and deleading activities. An analysis prepared in support of the regulation (i.e., to meet the requirements of Executive Order 12291 and the Regulatory Flexibility Act) for the Occupational Safety and Health Administration (OSHA) titled "Economic Analysis of OSHA's Interim Final Standard for Lead in Construction" (CONSAD, 1993) provides an analysis of the effect on mean blood levels of construction workers. While the information in Appendix D of the OSHA report does not support a full analysis of the impacts of §§402(a) and 404, it does allow quantification of the likely size of some of the impacts, and an exploration of what the potential size of the worker benefits might be.

The OSHA regulation lowered the 8-hour time weighted average PEL for lead from 200μg/m^3 to 50μg/m^3. The PEL analysis included the following steps to estimate the impacts on workers:

- For 31 different construction activities, OSHA developed a profile of worker exposure to airborne lead during that activity. Two of the construction activities involve residential abatements, and are used in this analysis of §§402(a) and 404. The included practices are: Combined Abatement Activities-HUD practice, and Combined Lead Paint Removal/Remodeling Activities-Poor Practice.

- Patterns of worker exposure were identified to characterize intermittency;

- The resulting exposure profiles were entered into a pharmacokinetic model (the Simulated Control Program (SCOP), Version 3.3) to generate a blood lead profile for each group of workers.

- The blood lead profiles were used to calculate the mean and peak blood lead levels for each group of workers.

The OSHA analysis identified two levels of worker blood lead levels: one for workers performing abatements following "HUD practice", and one for workers following "poor practices". The "HUD practice" refers to guidance put out by HUD that identifies reasonable workplace practices that workers should follow. These practices, in combination with the OSHA PEL limit (which can be met by wearing industrial respirators during periods of high exposure to lead paint during abatements) form a "regulatory baseline" for the workers benefit analysis. This regulatory baseline reflects common practices at the time the §§402(a) and 404 standards take effect. OSHA also estimates that approximately twenty percent of the workforce engaged in private housing unit abatements would not follow the HUD good practices and meet the OSHA PEL, largely because respirator use was not rigorously enforced at the worksite.

The combination of the mandatory §402(a) training, and the requirement that properly certified workers and firms must conduct all abatements under §§402(a), should eliminate non-compliance with the HUD good practice standards and the OSHA PEL. In fact, the §402(a) program could provide significant further worker protection beyond that assumed in the OSHA PEL analysis, because the training is more rigorous and comprehensive (the OSHA training is four hours long, and the §402(a) worker training is two days long), the use of certain practices are restricted, and the penalty for non-compliance (loss of certification) is severe. However, the amount of further protection that will occur due to §§402(a) and 404 cannot be quantified. The workers benefits assessment from §§402(a) and 404 assumes only that the twenty percent non-compliance with the OSHA PEL and HUD practices will be eliminated. While this assumption may overestimate the additional compliance with the OSHA PEL due to the §402(a) training, it may underestimate the increased worker protection that results from more intense training.

The blood lead assumptions derived from the PEL analysis that are used in the §402(a) worker benefit analysis are shown in Exhibit 7.4. These reductions in blood lead levels are assumed to only occur for workers and supervisors involved with abatements. This will underestimate the total worker benefits, as other labor categories involved with abatements (e.g., risk assessors and inspectors) are also likely to experience lower blood lead levels because of adequate training and improved practices. However, it is impossible to quantify the magnitude of the blood lead level decreases in these workers.

All of the abatement workers and supervisors are assumed to be men, and the male-only concentration-response functions are used. While this is likely to be an overestimate, information is not available at this time on the proportion of the abatement workers that are women. Because women are less susceptible to the damages of elevated blood lead levels, the benefits estimates will be somewhat overestimated if women make up a portion of the workforce.

The workforce is also assumed to have the same age distribution as the general male population between the ages of 20 and 59. This assumption may not be correct, as the construction industries often hire a relatively younger workforce than other industries. If the age distribution of actual abatement workers is more skewed to the younger ages than the general population, the benefits may be overestimated. Many of the excess serious adult health effects from lead occur due to elevated blood pressure, and the incidence of serious health effects caused by a one point increase in diastolic blood pressure increase with age.

Three categories of health effects related to elevated blood lead levels are estimated for the abatement workers: hypertension, first time non-fatal heart attacks and strokes, and death. The incidence of excess cases of these health effects are predicted using dose-response functions described in Appendix 7A. The following economic values are attached to the four health endpoints:

- Hypertension: $767 per case (from Cost of Illness studies)
- Mortality: $5.5 million/statistical life (as described above)
- Heart Attack and Strokes: $1.76 million (32 percent of the value of a statistical life, from risk/risk tradeoff studies conducted by Viscusi et al. (1991) and Krupnick and Cropper, (1992)).

The quantified economic benefits of these avoided worker health effects are shown in Exhibit 7.5. It is likely that these benefits of $154.7 million underestimate the total impact of §§402(a) and 404, because these benefits are calculated only for twenty percent of the workforce currently using poor practices. All of the workforce, including the eighty percent

Exhibit 7.4: Abatement Worker Blood Lead Levels Following Implementation of 50 μg/m^3 PEL		
	Mean Blood-Lead Levels (μg/dL)	**% of Workers in First Year of Final Rule**
Combined Lead Paint Removal/Remodeling Activities-Poor practice	33.8 (SE=15)	20%
Combined Abatement Activities HUD Practice	7.2 (SE=1.4)	80%
Source: "Economic Analysis of OSHA's Interim Final Standard for Lead in Construction," OSHA, 1993.		

already using HUD good practices and meeting the OSHA PEL and the twenty percent that are assumed to begin meeting the current industry standard, will likely enjoy additional blood lead reductions. The economic benefits of this additional improvement are not included in Exhibit 7.5.

7.5 Resident Adult Blood Pressure Related Health Benefits

Quantifying and monetizing the health benefits of reducing the lead exposure of adult residents of abated housing units is difficult because there is insufficient information on the relationship between residential adult blood pressure and the presence of lead-based paint or lead contaminated soil. The omission of adult residents' benefits is a potentially serious underestimate of the benefits of §§402(a) and 404, because even relatively small changes in adult blood lead (PbB) levels result in substantial benefits. In order to address the sensitivity of the analysis to the omission of adult benefits, estimates of the potential adult benefits are presented here for two levels of changes in adult blood lead levels: the benefits of a small change is estimated assuming a 0.1 μg/dL change in blood lead levels, and the benefits of a larger possible change is estimated assuming the same blood lead change (2.13 μg/dL) used for pregnant female residents calculating the neonatal mortality benefits.

The number of abatements that are conducted each year is a very important component for all of the benefits analysis. The sensitivity analysis for health benefits to adult residents assumes that the same number of abatements occur each year that were used in the primary analysis in Chapters 5 and 6. Making this assumption reduces the scope of the analysis of adult resident benefits to a task of estimating the adult benefits that may be associated with each abatement that is conducted. The estimated adult resident benefits per abatement can be simply added to the per-abatement benefits estimated in Chapters 6.

Exhibit 7.5: Abatement Worker Economic Benefits			
	Benefits per Abatement	**Present Value of Benefits from First Year Abatements (Millions)**	**Present Value of Benefits from First Year Abatements (Millions)**
Target Housing[1]	$85	$4.8	$152.5
Child-Occupied Facilities[1]	$166	$0.084	$2.2
[1] Incremental benefits of §§402(a) and 404.			

Elevated blood pressure can directly result in hypertension (defined as diastolic blood pressure greater than 90 mm Hg), coronary heart disease, stroke, and premature death. The incidence of excess cases of these health effects are predicted using the dose-response functions described in Appendix 7.A. Because the incidence of each of these health effects is assumed to be caused by elevated blood pressure, these health effects are referred to as blood pressure related health effects. The benefits of changing blood lead levels through lead paint abatement is accomplished by a series of steps:

Step 1: Baseline Blood Lead Level

The starting place for the model is the baseline blood lead (PbB) levels in adults. The baseline describes the pre-regulatory distribution of population PbB levels, and can be fully described by the geometric mean (GM) and the geometric standard deviation (GSD) of the population. The baseline PbB is not calculated by the model: estimating the starting PbB conditions is outside the scope of the model. Since the analysis concerns the effects of abatements on PbB levels, future PbB levels are assumed to be the same as the baseline levels if lead paint is not abated. EPA (reported in AAI, 1993a) previously estimated the national adult male GM blood lead level in 1992 as 4.3 µg/dL, with a GSD of 1.39 and this distribution was used for the analysis.

The CDC (1991) reported that blood lead levels in pregnant women were substantially higher for women living in non-abated public housing in Cincinnati than for women living in lead-free public housing constructed after 1978. The CDC reported the difference was 2.13 µg/dL. This is the only known quantified blood lead level changes in adults due to residential lead paint abatement. Therefore, a 2.13 µg/dL change in blood lead is used as one possible basis for estimating the benefits of residential lead paint abatement for all adults living in housing with substantial potential exposure to lead paint. An alternative change in adult blood lead levels of 0.1 µg/dL is also used to develop a sensitivity benefits estimate. This 0.1 µg/dL was chosen for illustrative purposes.

The 4.3 μg/dL national adult male baseline blood lead level is assumed to be the average of all adult males and females, including those living in housing with lead paint, and those living in lead paint free housing. For the purposes of this analysis, housing with lead paint (defined as lead content in the paint of 1 mg/cm^2 or more) are assumed to increase the blood lead levels of adult residences by a specified amount (alternative assumptions are 2.13 μg/dL and 0.1 μg/dL). Based on HUD survey data, there are approximately 27.1 million pre-1980 housing units with lead paint. There are a total of 98.1 million housing units in use (in 1990) of any age, so there are 71.0 million homes without lead paint. Therefore the adults living in the 71.0 million homes are assumed to have a blood lead level 2.13 μg/dL (or alternatively 0.1 μg/dL) less than the households in the 27.1 million homes with lead paint. The geometric mean baseline blood lead levels for the adults living in each type of house is calculated by solving the following equation for X (the baseline blood lead level for people living in houses with lead paint:

$$\left(\frac{\mathbf{71.0\ million}}{\mathbf{98.1\ million}}\right) * \mathbf{X\ \mu g/dL} + \left(\frac{\mathbf{27.1\ million}}{\mathbf{98.1\ million}}\right) * \mathbf{(X + 2.13)\mu g/dL} = \mathbf{4.3\mu g/dL}$$

The solution to this equation is X = 3.71 μg/dL. Thus the baseline adult PbB for houses with lead paint is 5.84 μg/dL (3.71 + 2.13 = 5.84), and the post-abatement blood lead level (for all adult nationwide) is 3.71 μg/dL. The geometric standard deviation is assumed to remain at 1.39. A similar equation is solved for an assumed adult blood lead level change of 0.1 μg/dL.

Step 2: Calculate the number of baseline cases for each health effect

Given the estimated geometric mean blood lead for the exposed adult population, the baseline number of cases for each health effect are calculated. The estimated number of baseline cases depends on the background mean PbB, and the size of the exposed population. The probability that, for any given blood lead level, an adult (in the appropriate age range) will have hypertension, a stroke, coronary heart disease, or premature mortality are calculated using the probabilistic equations described in Appendix 7A.

The baseline estimate of the occurrences of each health effect are calculated on a per-housing-unit-abated basis. By calculating the per-unit benefits, it is easy to calculate the total adult benefits for any number of units that will be abated, or for any time pattern of abatement. The number of adult males and females living in each housing unit is estimated by dividing the total population of adult males and females by the number of housing units. Because the different health effect calculations are only established for specific age ranges, it is necessary to calculate the number of males and females within each age range living in each unit. The probabilities of occupancy in each age range are shown in Exhibit 7.6. The fractional numbers of adults per housing unit may be interpreted as the probability that an adult of that age range will live in a typical housing unit. For example, the average housing unit is occupied by .86 adult males between the ages of 20 and 74. The adult male age distribution is such that the .86 men per unit are composed of .44 men between 20 and 39, .10 men between 40 and 44, and the like.

Multiplying the probability that a health effect will occur times the probability that a person who might get that health effect lives in the house produces an estimate of the joint probability that the house will have a resident who will experience the health effect.

Step 3: Calculate the number of post-abatement cases for each health effect

Given the reduced mean blood lead of 3.79 µg/dL (with the GSD assumed unchanged) for adult occupants of abated homes, the probability of each health effect occurring is calculated. This step essentially repeats Step 2 using the abated home blood lead level.

Step 4: Calculate the change in the number of cases of each health effect

Given the baseline number of cases (Step 2) and the post-control number of cases (Step 3), the number of cases avoided is calculated by subtraction. This step produces the estimate of the change in the probability that an adult resident of a typical home will suffer each health effect. For example, for each housing unit that is abated, this step combines the information on the probability of a male of a particular age range living in the house, with the probability of a male in that age range suffering a particular health effect. A similar calculation is performed for females. The resulting change in the probability that each health effect will occur in a house is shown in Exhibit 7.7.

Step 5: Calculate the value of the change in health effects

Given the monetized benefit of each health effect (i.e., the willingness to pay to avoid an adverse health event or condition), the probability of a house having an occupant that suffers a particular health effect is multiplied by the benefit per health effect to calculate the aggregate willingness to pay for reduced lead exposure. This aggregate total is the measure of average adult hypertension related benefits of abating lead paint in a typical house.

The following economic values are attached to the four health endpoints:

- Hypertension: $767 per case (from Cost of Illness studies described below)
- Mortality: $5.5 million/statistical life (as described above)
- Heart Attack and Strokes: $1.76 million (32 percent of the value of a statistical life, from risk/risk tradeoff studies conducted by Viscusi et al. (1991) and Krupnick and Cropper, (1992)).

The mortality effects are valued at $5.5 million per statistical avoided death, as was done for the neonatal mortality. The value of avoiding a stroke and a CHD event is based on studies by Viscusi et. al (1991) and Krupnick and Cropper (1992) of the willingness to

Exhibit 7.6: Adult Age Distribution per Housing Unit

Age Range	1991 U.S. Male Population (millions)	Male Residents per Unit	1991 U.S. Female Population (millions)	Female Residents per Unit	Quantified Health Effects*
20-74	81.2	.86	NA**	NA**	Hypertension
40-59	26.8	.28	28.1	.30	CHD
55-64	9.9	.11	11.1	.12	CHD***
65-74	8.0	.09	10.3	.11	CHD
45-74	30.5	.32	34.5	.37	Stroke
40-54	21.8	.23	22.7	.24	Mortality
55-64	9.9	.11	11.1	.12	Mortality
65-74	8.0	.09	10.3	.11	Mortality
TOTAL	81.2	0.86	85.2	.90	

* Key to Health Effects: CHD = Coronary Heart Disease (heart attack), stroke = stroke, mortality = premature mortality due to any cause.

** There is not a female hypertension dose response function available at this time, so hypertension benefits are not calculated for females.

*** Two different sources for the male CHD dose-response function are used. The age ranges in the two sources are slightly different. Double counting of males in the age range 56-59 is avoided by matching the appropriate male population and occupancy per unit with each dose-response functions. As all female CHD dose-response functions come from a single source, this problem is avoided for females.

Population figures source: U.S. Department of Commerce, Bureau of the Census, Current Population Reports, U.S. Population Estimates, by Age, Sex, Race, and Hispanic Origin: 1980 to 1991, Table 1. Resident Population -- Estimates by Age, Sex, Race and Hispanic Origin, July 1, 1991.

Household figure source: U.S. Department of Commerce, Bureau of the Census, Population Division, Table 18. Households, by Type, Age of Members, Age, Sex, Race, and Hispanic Origin of Householder: March 1991.

Exhibit 7.7: Reductions in the Probability of Health Effects in Adult Residents of an Abated Housing Unit (assuming a 2.13 μg/dL change in adult blood lead levels)

Health Effect	Affected Age Range	Males Change in Probability*	Females Change in Probability*
Hypertension	20-74	0.136	NA
Coronary Heart Disease	40-59	.000304	
Coronary Heart Disease	60-64	.000585	
Coronary Heart Disease	65-74	.000510	
Coronary Heart Disease	45-74		.000077
Stroke	45-74	.000272	.000035
Mortality	40-54	.000476	
Mortality	55-64	.000623	

pay to avoid a statistical case of chronic bronchitis. By assuming that people believe the pain, suffering and activity restrictions associated with a non-fatal CHD event or stroke are at least as severe as those in chronic bronchitis, the value of avoiding a non-fatal stroke or CHD event is equated with Viscusi's value of chronic bronchitis, as 32 percent of a death, estimated using a risk-risk tradeoff. The willingness to pay for avoiding stroke and coronary heart disease, therefore, is assumed to be 32 percent of the value of avoiding premature mortality. Consequently, lead's stroke and coronary heart disease effects are valued at $1,760,000 per statistical case of avoided stroke or heart attack.

Willingness to pay to avoid hypertension has not been estimated, and cannot be quantified without basic research well beyond the scope of this analysis. Instead, an estimate of the annual direct medical costs of hypertension (including physician charges, medication costs, hospitalization costs and lost work time) are used as a proxy for the value of hypertension. The annual medical cost of treating hypertension is assumed to be $767 (1994 dollars) (from AAI, 1993a). The direct medical costs are likely to be an underestimate of the true social benefit of avoiding a case of hypertension for several reasons. First, a measure of the value of pain, suffering and stress associated with hypertension is not included. Second, the direct costs (out-of-pocket expenses) of diet and behavior modification (e.g., salt-free diets, etc.) are not valued. These costs are likely to be significant, since modifications are typically severe. Third, the loss of satisfaction associated with the diet and behavior modifications are ignored. Finally, the medication for hypertension can produce side effects in some people including drowsiness, nausea, vomiting, anemia, impotence, cancer, and depression. The benefits of avoiding these side effects are not included in this estimate.

The estimated annual value of blood pressure related benefits from abating one house is $1,091 for a 2.13 µg/dL change in blood lead levels, or $55 for a 0.1 µg/dL change. Because these benefits are assumed to occur each year for next 50 years, the present value of the 50 year stream of benefits (using a three percent discount rate) must be calculated. Thus the per-abatement adult benefits assuming a 2.13 µg/dL change is $28,067, and $1,423 for a 0.1 µg/dL change. The details of these calculations are shown in Exhibit 7.8.

These benefits per abatement may be used to calculate a present value of the potential adult benefits of total abatements assuming the same number and time path of abatements used in the primary analysis.

Exhibit 7.8: Monetized Adult Blood Pressure Related Health Effects

Health Effect	**Value per Case of Health Effect** (1994 dollars)	**Expected Annual Value Per Abatement (2.13 µg/dL change)**	**Expected Annual Value Per Abatement (0.1 µg/dL change)**
Hypertension (male)	$767	$35	$2
Coronary Heart Disease	$1,760,000	$213	$11
Stroke	$1,760,000	$103	$5
Mortality	$5,500,000	$740	$38
Total Annual Benefit†		$1,092	$55
Per Abatement Present Value of Benefits		$28,067	$1,423
Present Value of Adult Benefits from All Housing Abatements		$36.0 billion	$1.8 billion

† Columns may not sum due to rounding

7.6 Alternative Discount Rate

Since the benefits resulting from this regulation will not occur simultaneously with the costs, it is necessary to compare streams of costs with the resulting streams of benefits. This is done by discounting future costs and benefits and summing the discounted values. In the case of this analysis, the relevant period of time is 50 years.

The results present in Chapters 5 and 6 use an annual discount rate of three percent to reflect the social rate of time preference for annualized costs and benefits. An alternative discount rate is investigated here. The Office of Management and Budget (OMB) guidance recommends use of a seven percent discount rate. Exhibit 7.9 compares the 50-year streams of costs discounted at seven percent with those discounted at three percent. This increase in the discount rate decreases the total 50-year cost estimate by 52 percent.

Increasing the discount rate results in a slightly larger reduction in work practice standards costs than in the training or state program costs. This is due to the distribution of activities over time. Work practice standards costs are relatively constant over time, while both training and state program costs are higher in the first years than in the later years, due to start-up activities.

Increasing the discount rate to seven percent also substantially decreases the estimated benefits, because many of the benefits will occur in the future. There are potentially two separate effects of changing the discount rate. First, the benefits per abatement decrease for the children's intelligence effects decrease by more than 80 percent. These per-abatement benefits are largely derived from the estimated impact on the discounted future income stream. Since the change in income earned during adulthood will occur relatively far in the future, the impact of using a higher discount rate is pronounced. Second, the present value of the 49-year benefits decreases for all the benefit categories. The combination of these two effects lowers the present value of the 49-year benefit stream by approximately 90 percent. The per-abatement benefits estimates for residential abatements using three and seven percent discount rates are shown in Exhibit 7.10, and the present value of the benefits are shown in Exhibit 7.11.

Exhibit 7.9: Comparison of Incremental Costs Under Alternative Discount Rates (Costs in $ millions)

	Discounted Costs Fifty Years 3% Discount Rate	Discounted Costs Fifty Years 7% Discount Rate	% Change from Primary Analysis
Training	$228	$108	- 52 %
Standards	$637	$291	- 54 %
State Programs	$249	$131	- 47 %
Total	$1,114	$530	- 52 %

7.7 Summary

As shown by the sensitivity analyses presented in this chapter, the total cost estimates are highly affected by changes in the discount rate and changes in soil abatement work practices. On the other hand, changes in demand for inspectors and risk assessors cause only minor effects on the total cost estimates.

Using a discount rate of seven percent, as opposed to the three percent social discount rate used in the primary analysis, reduces the discounted 50-year stream of costs by 52 percent (see Exhibit 7.12). As shown below, benefits also drop sharply when a seven percent discount rate is used.

As with the cost estimates, the benefit estimates are very sensitive to the discount rate (see Exhibit 7.13). Using a seven percent discount rate results in a 90 percent decrease in the estimated benefits from a 49-year stream of residential abatements. Including benefits to adult residents can substantially increase total benefits, depending on assumptions about the size of the blood lead change. Alternative values of a statistical life have a smaller effect on the benefit estimates.

Exhibit 7.10: Comparison of Estimated Benefits Per Abatement for Complete Abatements Using Alternative Discount Rates

Benefit Category	Value Per Abatement Primary Analysis 3% Discounting	Value Per Abatement 7% Discounting	% Decrease from Primary Analysis
Infant/Children Intelligence Effects, Target Housing Abatements*	$9,181	$1,768	- 80%
Other Infant & Children Neurological Effects	Not Measured	Not Measured	-
Neonatal Mortality	Not Measured	Not Measured	-
Other Adult Resident Health Effects	Not Measured	Not Measured	-
Infant/Children Intelligence Effects, Child-Occupied Facility Abatements*	$268,431	$38,932	- 85%

All figures in 1994 dollars.
* Total measured benefits of abatements, not just incremental benefits from TSCA §402.

Exhibit 7.11: Comparison of Present Value Estimated Benefits for Complete Residential Abatements Using Alternative Discount Rate			
Benefit Category	**Present Value** Primary Analysis 3% Discount Rate	**Present Value 7% Discount Rate**	**% Decrease from Primary Analysis**
Infant/Children Intelligence Effects, Target Housing Abatements *	$13.1 billion	$1.1 billion	- 91%
Other Infant & Children Neurological Effects	Not Measured	Not Measured	-
Neonatal Mortality	Not Measured	Not Measured	-
Other Adult Health Effects	Not Measured	Not Measured	-
Infant/Children Intelligence Effects, Child-Occupied Facility Abatements *	$3.0 billion	$455 million	- 85%
Total **	$16.1 billion	$1.55 billion	- 90%

All figures in 1994 dollars

* Total measured benefits of abatements, not just benefits from TSCA §402.

** Combination of total and incremental benefits.

Exhibit 7.12 Sensitivity of Incremental Cost Estimates to Variations in the Value of Key Variables			
	Total Discounted Costs ($ millions)		
Variation in Key Variable	**Primary Analysis**	**Sensitivity Analysis**	**% Change from Primary Analysis**
Reduce the Demand for Inspectors and Risk Assessors	$1,114	$1,050	-6%
Use 7% Discount Rate		$530	-52%
Increase Soil Abatement Depth (to 6")		$1,406	+26%

Exhibit 7.13
Sensitivity of Benefit Estimates to Variations in the Value of Key Variables

Variation in Key Variable	Total Discounted Benefits ($ billion) Primary Analysis	Total Discounted Benefits ($ billion) Sensitivity Analysis	% Change from Primary Analysis
Include Benefits to Adult Residents, Assuming 2.13 µg/dL Change in Blood Lead	$16.1	$52.1	+ 224%
Include Benefits to Adult Residents, Assuming 0.1 µg/dL Change in Blood Lead		$17.9	+ 11%
Include Benefits to Workers (Capturing 20% of Workers not covered by OSHA PEL)		$16.3	+ 1%
Include Neonatal Mortality, Assuming 2.13 µg/dL Change in maternal Blood Lead		$17.6	+ 9%
Use 7% Discount Rate		$1.6	- 90%

Appendix 7.A Summary of Dose-Response Relationships for Quantified Health Effects

This appendix discusses the dose-response relationships for the three sensitive population groups identified by USEPA (1990): pregnant women (principally as exposure surrogates for the fetus), pre-school age children; and adult men and women. The health effects for each of these subpopulations has been summarized in section 3.1.1 and Exhibit 3.1; this appendix augments that discussion by providing the equations used to quantify the health effects.

Health Hazards for Infants Less Than One Year Old Two health benefits were quantified, a decrease in infant mortality use the Centers for Disease Control (CC, 1991) estimate that the risk of infant mortality decreases by 10^{-4} (or 0.0001) for each 1 µg/dL decrease in maternal blood lead level during pregnancy. Neurobehavioral deficits in infants are also quantified through IQ decrements as shown below for children.

Health Hazards for Children Between One and Six Years Old Although elevated levels of blood lead in children can result in many health effects, as listed in Chapter 3, only the neurobehavioral effects as expressed in IQ decrements have been quantified in this analysis. A dose-response relationship for IQ decrements can be estimated from a meta-analysis of seven research studies (Schwartz, 1993). Regression coefficients for each study were used to determine a weighted average linear regression coefficient for the relationship between PbB and IQ. Each regression coefficient was weighted by the inverse of the variance of each estimate. In order to determine an overall coefficient, the regression coefficients for studies that used natural logarithms of the levels of lead in blood (PbB) as the exposure index were linearized. In general, the coefficient was linearized in the PbB range of 10 to 20 µg/dL. However, in one study (Bellinger et al. 1991), 70 percent of the data was below 10 µg/dL; thus the data was linearized in the 5 to 15 µg/dL range. For the studies that did not transform PbB concentrations, the regression coefficients were used directly. Given the typical uncertainty within individual studies, the variation in the regression coefficients among studies was not more than would be expected. The resulting relationship suggests that for a 1 µg/dL increase in PbB, a decrease of 0.25 IQ points can be expected. The p-value (< 0.0001) indicates that this relationship is highly significant.

Health Hazards for Men Four health endpoints related to elevated lead levels, are analyzed quantitatively for adult men: hypertension; non-fatal heart attack and non-fatal stroke; and premature death. A dose-response relationship is available for each of these effects. Hypertension, defined as diastolic blood pressure above 90 mm Hg for this report, is modeled for males aged 20-74 years using a relationship developed by Schwartz (1988). This relationship is:

$$\Delta Pr(HYP) = \frac{1}{1 + e^{2.744 - .793*(\ln PbB_1)}} - \frac{1}{1 + e^{2.744 - 0.793*(\ln}} \qquad \textbf{(7A.1)}$$

where,

ΔPr(HYP)	=	the change in the probability of hypertension;
PbB_1	=	blood lead level before some change in exposure; and,
PbB_2	=	blood lead level after some change in exposure.

As noted in Chapter 3, high blood pressure has been identified as a risk factor in a number of cardiovascular illnesses (Shurtleff 1974, McGee and Gordon 1976, Pooling Project 1978). Using the relationship between blood pressure and other health effects the increased probabilities of the initial occurrence of heart attack and stroke can be predicted (USEPA 1987). The equation for estimating changes in diastolic blood pressure as a result of changes in blood lead levels is:

$$\Delta BP_{men} = 2.74\ (\ln PbB_1 - \ln PbB_2\ ) \qquad \textbf{(7A.2)}$$

where,

ΔBp_{men} =		the change in men's blood pressure expected from a change in PbB;
PbB_1	=	blood lead level before some change in exposure; and,
PbB_2	=	blood lead level after some change in exposure.

These blood pressure changes can be used to predict the probabilities of first-time heart attacks and strokes. Increased blood pressure would also increase the probability of reoccurrences of heart attacks and strokes, but these quantified relationships are not available. First-time heart attacks (coronary heart disease events) in men can be predicted using a equation with different parameters for each of three age groups. For men between 40 and 59 years old, the following equation using information from Pooling Project (1978) is used:

$$\Delta Pr(CHD_{40-59}) = \frac{1}{1 + e^{4.996 - 0.030365*BP_1}} - \frac{1}{1 + e^{4.996 - 0.0303}} \qquad \textbf{(7A.3)}$$

where,

$\Delta Pr(CHD_{40-59})$	=	change in 10 year probability of occurrence of CHD event for men between 40-59 years old;
BP_1	=	mean diastolic blood pressure before regulatory controls; and,
BP_2	=	mean diastolic blood pressure after controls.

The relationship between BP and first time heart attacks in older men was determined from Shurtleff (1974). This study used univariate statistics to estimate the relationship between BP and a variety of health effects. For men aged 60 to 64 years old, first-time heart attacks can be predicted from the following equation:

$$CHD_{60-64}) = \frac{1}{1 + e^{5.19676 - 0.02351 * BP_1}} - \frac{1}{1 + e^{5.19676 - 0.02}} \quad \textbf{(7A.4)}$$

where,

$\Delta Pr(CHD_{60-64})$ =		change in 10 year probability of occurrence of CHD event for men from 60 to 64 years old;
BP_1	=	mean diastolic blood pressure before regulatory controls; and,
BP_2	=	mean diastolic blood pressure after controls.

For men aged 65 to 74 years old, the following equation uses data from Shurtleff (1974) to predict the probability of first-time heart attacks:

$$CHD_{65-74}) = \frac{1}{1 + e^{4.90723 - 0.02031 * BP_1}} - \frac{1}{1 + e^{4.90723 - 0.02}} \quad \textbf{(7A.5)}$$

where,

$\Delta Pr(CHD_{65-74})$ =		change in 10 year probability of occurrence of CHD event for men from 65 to 74 years old;
BP_1	=	mean diastolic blood pressure before regulatory controls; and,
BP_2	=	mean diastolic blood pressure after controls.

Two types of health events are categorized as strokes: initial cerebrovascular accidents (CA) and initial atherothrombotic brain infarctions (BI). The risk has been quantified for the male population between 45-74 (Shurtleff 1974). For initial cerebrovascular accidents, the logistic equation is:

$$CA_{men}) = \frac{1}{1 + e^{8.58889 - 0.04066 * DBP_1}} - \frac{1}{1 + e^{8.58889 - 0.0406}} \quad \textbf{(7A.6)}$$

where,

$\Delta Pr(CA_{men})$	=	change in 2 year probability of cerebrovascular accident in men;
DBP_1	=	mean diastolic blood pressure before regulatory controls; and,
DBP_2	=	mean diastolic blood pressure after controls.

For initial atherothrombotic brain infarctions, the logistic equation is:

$$(BI_{men}) = \frac{1}{1 + e^{9.9516 - 0.04840*DBP_1}} - \frac{1}{1 + e^{9.9516 - 0.04840*}} \quad \textbf{(7A.7)}$$

where,

$\Delta Pr(BI_{men})$	=	change in 2 year probability of brain infarction in men;
DBP_1	=	mean diastolic blood pressure before regulatory controls; and,
DBP_2	=	mean diastolic blood pressure after controls.

Information also exists to predict the increased probability of premature death from all causes as a function of elevated blood pressure. USEPA (1987) used population mean values for serum cholesterol and smoking to reduce results from a 12 year follow-up of men aged 40-54 in the Framingham Study (McGee and Gordon 1976) to an equation in one explanatory variable:

$$ORT_{45-54}) = \frac{1}{1 + e^{5.3158 - 0.03516*DBP_1}} - \frac{1}{1 + e^{5.3158 - 0.03}} \quad \textbf{(7A.8)}$$

where,

$\Delta Pr(MORT_{45-54})$=		the change in probability of death for men aged 45-54;
DBP_1	=	mean diastolic blood pressure before regulatory controls; and,
DBP_2	=	mean diastolic blood pressure after controls.

Information from Shurtleff (1974) can be used to estimate the probability of premature death in men older than 54 years old. For men aged 55 to 64 years old, mortality can be predicted by the following equation:

$$ORT_{55-64}) = \frac{1}{1 + e^{4.89528 - 0.01866*DBP_1}} - \frac{1}{1 + e^{4.89528 - 0.0}} \quad \textbf{(7A.9)}$$

where,

$\Delta Pr(MORT_{55-64})$=		the change in probability of death in men aged 55-64;
DBP_1	=	mean diastolic blood pressure before regulatory controls; and,
DBP_2	=	mean diastolic blood pressure after controls.

For men aged 65 to 74 years old, premature mortality can be predicted by the following equation:

$$ORT_{65-74}) = \frac{1}{1 + e^{3.05723 - 0.00547 * DBP_1}} - \frac{1}{1 + e^{3.05723 - 0.0}} \quad \textbf{(7A.10)}$$

where,

$\triangle$Pr($MORT_{65-74}$)=		the change in probability of death in men aged 55-64;
DBP_1	=	mean diastolic blood pressure before regulatory controls; and,
DBP_2	=	mean diastolic blood pressure after controls.

Health Hazards for Women As with men, blood pressure changes due to elevated blood lead levels can contribute to non-fatal heart attacks and strokes as well as premature death. A quantitative estimate of female blood pressure related to PbB can be estimated from a recent review of ten published studies (Schwartz, 1992). All of the reviewed studies included data for men, and some included data for women. A concordance procedure was used to combine data from each study to predict the decrease in diastolic BP associated with a decrease from 10 µg/dL to 5 µg/dL PbB. The results suggest that this decrease in PbB would decrease diastolic BP by 1 mmHg in adult males, and about 0.6 mmHg in adult females. Thus, lead's effect on BP in women is estimated to be 60 percent of the effect seen in men. Applying this value to Equation 7A.2 for men, the resulting equation is:

$$\triangle BP_{women} = (0.6*2.74)\,(\ln PbB_1 - \ln PbB_2\,) \quad \textbf{(7A.11)}$$

where,

$\triangle BP_{women}$	=	the change in women's blood pressure expected from a change in PbB;
PbB_1	=	blood lead level before some change in exposure; and,
PbB_2	=	blood lead level after some change in exposure.

Elevated blood pressure in women results in the same effects as for men (the occurrence of heart attack, two types of stroke, and premature death). However, the general relationships between BP and these health effects are not identical to the relationships for men. All these relationships have been estimated for women aged 45 to 74 years old using information from Shurtleff (1974). First-time heart attacks in women can be estimated from the following equation:

$$CHD_{women}) = \frac{1}{1 + e^{6.9401 - 0.03072 * BP_1}} - \frac{1}{1 + e^{6.9401 - 0.030}} \quad \textbf{(7A.12)}$$

where,

$\triangle$Pr(CHD_{women})	=	change in 10 year probability of occurrence of CHD event for women aged 45-74;
BP_1	=	mean diastolic blood pressure before regulatory controls; and,
BP_2	=	mean diastolic blood pressure after controls.

The relationship between BP and initial cerebrovascular accidents can be predicted by the following the logistic equation:

$$A_{women}) = \frac{1}{1 + e^{9.07737 - 0.04287*DBP_1}} - \frac{1}{1 + e^{9.07737 - 0.042}} \qquad \textbf{(7A.13)}$$

where,

$\triangle Pr(CA_{women})$ = change in 2 year probability of cerebrovascular accident in women aged 45-74;

DBP_1 = mean diastolic blood pressure before regulatory controls; and,

DBP_2 = mean diastolic blood pressure after controls.

For initial atherothrombotic brain infarctions in women, the logistic equation is:

$$BI_{women}) = \frac{1}{1 + e^{10.6716 - 0.0544*DBP_1}} - \frac{1}{1 + e^{10.6716 - 0.054}} \qquad \textbf{(7A.14)}$$

where,

$\triangle Pr(BI_{women})$ = change in 2 year probability of brain infarction in women aged 45-74;

DBP_1 = mean diastolic blood pressure before regulatory controls; and,

DBP_2 = mean diastolic blood pressure after controls.

The risk of premature mortality in women can be estimated by the following equation:

$$RT_{women}) = \frac{1}{1 + e^{5.40374 - 0.01511*DBP_1}} - \frac{1}{1 + e^{5.40374 - 0.}} \qquad \textbf{(7A.15)}$$

where,

$\triangle Pr(MORT_{women})$= the change in probability of death for women aged 45-74;

DBP_1 = mean diastolic blood pressure before regulatory controls; and,

DBP_2 = mean diastolic blood pressure after controls.

8. BENEFIT-COST ANALYSIS

A thorough analysis of TSCA §402(a), as well as the state model program developed under §404, should include the calculation of net benefits, based on the incremental costs and the incremental benefits resulting from this rule. The rule requires training of all personnel involved in lead-based paint activities and implementation of work performance standards for these activities; both actions are expected to increase the benefits from lead abatements but also increase the costs. The net benefit analysis should compare these benefit increases (incremental benefits) to the cost increases (incremental costs) to determine if the incremental benefits justify the incremental costs.

While there exist some uncertainties on the cost side, particularly about the cost increases due to the work practice standards sections of the rule, a reasonable estimate can be made of the costs. Calculating the **incremental** benefits of §§402(a) and 404 **for all** categories of benefits, however, is **not possible** at this time because much of the necessary information is unavailable. The estimation of benefits is limited by the lack of quantified information on the incremental reductions in human and ecosystem exposure that will result from the required training and work practice standards, as well as lack of information on some known or expected health effect categories. However, a reasonable estimate can be made of the total benefits from abatement.

In spite of these limitations, the information on costs and benefits presented in Chapters 5 and 6 are useful for informing the decision. It becomes even more useful when combined with the sensitivity analysis presented in Chapter 7. While the incremental benefits from the rule will be less than the total benefits of paint abatements, where incremental benefits are not known the total benefits can be used as a "benchmark" against which to compare the incremental costs to determine if it is likely that the incremental benefits of the rule would exceed the incremental costs.

8.1 Costs

The incremental costs of the rule were estimated for target housing and child-occupied facilities based on: 1) the **additional** training, certification, and performance actions specified by the rule, 2) the number of lead-based paint activities forecast, and 3) the number of personnel required to perform these activities. The estimated total incremental costs of the rule, summed over 50 years and discounted at 3 percent, are approximately $1,114 million (see Exhibit 8.1). Of this total, $637 million will be required to comply with the work practice standards, with smaller amounts due to training and to administering the program. Costs associated with target housing make up the vast majority of the total costs under this rule. Almost 99 percent of the costs are due to training, standards, and state program costs for target housing activities.

Exhibit 8.1: Comparison of Incremental Costs Due to Proposed Rule to Total Measured Benefits, for Abatements Over 50-Year Period (3 percent discount rate).			
TOTAL MEASURED BENEFITS FROM ABATEMENTS (except where noted)		**INCREMENTAL COSTS DUE TO REGULATION**	
Benefit Category	**Present Value**	**Cost Category**	**Present Value**
Target Housing Abatements			
Infant and Children Intelligence Effects — Total	$13,100 Million	Training Cost	$225 Million
		State Program Cost	$246 Million
		Standards Cost	$629 Million
Percent Value of 50 Year Stream — Residential	**$13,100 Million**	**Percent Value of 50 Year Stream — Residential**	**$1,100 Million**
Child-Occupied Facilities			
Infant and Children Intelligence Effects — Total	$3,000 Million	Training Cost	$2.2 Million
		State Program Cost	$3.1 Million
		Standards Cost	$8.4 Million
Present Value of 50 Year Stream — Child-Occupied Facilities	**$3,000 Million**	**Present Value of 50 Year Stream — Child-Occupied Facilities**	**$13.6 Million**
TOTAL PRESENT VALUE (SUM OF TARGET HOUSING AND CHILD-OCCUPIED FACILITIES): QUANTIFIABLE BENEFITS AND COSTS			
All Structure Types — 50 Year Stream	**$16,100 Million**	**All Structure Types — 50 Year Stream**	**$1,114 Million**

Since actions under this rule will continue far into the future, and the occurrence of the costs and benefits do not coincide, calculating the discounted present value is an appropriate way to aggregate the annual values. A fifty-year stream is considered for several reasons. Given the large number of target housing units and child-occupied facilities with lead-based paint, it will take a very long time to eliminate the problem. In addition, the present value of costs that will occur 50 years in the future is very small, so little is gained by carrying the estimates out further. (The benefits generated from the 50 years of abatement activities are also discounted.)

8.2 Benefits

The benefits to residents, as presented in Chapter 6, are estimates of the total measured benefits of complete target housing abatement and not the incremental benefits resulting from the rule. While the incremental benefits would be the appropriate benefits measure for assessing the impacts of TSCA §402(a), the incremental impacts of the rule cannot be isolated at this time. Estimating the total measured benefits of an abatement does, however, provide a useful benchmark to assess the likelihood that TSCA §402(a) will produce positive net incremental benefits.

The total measured benefits due to inspections, lead hazard screens and risk assessments, and abatements in target housing and child-occupied facilities is estimated to be $16.1 billion over 49 years of abatements and the 50 years of benefits associated with each abatement, discounted at 3 percent (see Exhibit 8.1). All of this total results from IQ benefits to children, with over 81 percent from lead-based paint activities in target housing. Since the benefit estimate includes only a narrow category of all the benefits, it is an underestimate of the benefits resulting from an abatement. On the other hand, the incremental benefits of §402(a) would be less than the total benefits of an abatement.

For example, this benefit estimate is an underestimate of the value of an abatement because it omits all the benefits of health effects for which quantified dose-response functions and/or per unit willingness-to-pay estimates are not available. As shown in the preceding sensitivity analysis, in Chapter 7, a major category of omitted benefits are those due to avoided neonatal mortality. These benefits are not included in the primary estimates because of the large uncertainty as to the decrease in blood lead levels of pregnant women due to abatements. Additional likely benefits that cannot be measured at this time are: neurological and behavioral effects in children such as hyperactivity and attention deficits, blood pressure-related effects in male and female adult residents, reproductive effects in women, and additional benefits that may accrue to labor categories performing lead-based paint activities.

Similar limitations apply to estimating benefits to children and abatement workers from lead-based paint activities in child-occupied facilities. In addition, benefits accruing to adult workers who spend substantial time in child-occupied facilities (e.g., teachers) were not estimated. This includes adult health effects such as hypertension and stroke, as well as neonatal mortality, which is the result of lead exposure in pregnant women. As with target housing, it is not possible to estimate the degree to which the overestimate due to the use of total benefits (as opposed to incremental benefits) is offset by the failure to include only certain benefit categories.

A potentially large subcategory of benefits are ecological benefits that have not been estimated due to lack of sufficient information. A qualitative discussion of these benefits is given in Chapter 6.

8.3 Comparison of Benefits and Costs

Exhibit 8.1 allows for a comparison of the present value estimates of total measured benefits and incremental costs for **target housing** units and **child-occupied facilities**. In the case of target housing, the estimated present value (using a three percent discount rate) of the **total measured** benefits are nearly 12 times the present value of the estimated **incremental** costs. In the case of child-occupied facilities, the relative magnitude of total measured benefits to incremental costs is even greater; total measured benefits are about 220 times incremental costs. Looking at both types of facilities (target housing and child-occupied facilities) combined, total measured benefits are about 14 times the incremental costs of this rule.

The ratio of benefits to costs for child-occupied facilities is so much larger than the ratio for target housing due to the large number of children in each COF affected by actions to reduce lead-based paint hazards. While the incremental cost of abating a child-occupied facility is estimated to be about two times the incremental abatement costs for a target housing unit, on average a child-occupied facility has many more children. As shown in Chapter 6, each day care center has about 62 children on average, while each housing unit has less than one child on average. Even taking into account that a child in day care, or kindergarten, spends less time per week there than at home, the total exposure of children is much greater. Therefore, the benefits from reducing the lead in a child-occupied facility are also much greater.

Another way to assess the overall affect of the rule is to evaluate the decisions of individual households and property owners. There are two decision scenarios to be considered. One applies to owners who decide to abate. In this case, the question to answer is: will the decision to abate continue to be a rational decision after the 402(a)/404 requirements take affect? In other words, if an owner decides to abate the lead-based paint, will the benefits exceed the costs? The second scenario applies to owners who undertake a lead-hazard identification and based on the information obtained decide to not have an abatement. Again the question is: will benefits exceed the costs to the property owner?

For the first scenario, the question can be answered by comparing the total costs of a typical residential abatement (including the incremental costs due to this rule) to the total average benefits per residential abatement. consistent with the analysis presented in Chapters 4 and 5, the cost of an abatement should include the costs of the lead-hazard identification activities that provide the information on which the decision to abate is based. In this particular example, the identification process is assumed to include an inspection and a risk assessment (which is slightly more expensive than the lead hazard screen). The total cost of the hazard identification activities and a permanent abatement, including the incremental costs resulting from the work practice standards, and the unit's pro-rated share of training costs and state administration costs, is $7,276, of which only $248 are incremental costs due to this rule. This total cost compares very favorably to the per residential abatement benefits to children of $9,181 (shown in Exhibit 6.4). As discussed in the section below, if it were possible to include the value of the other benefits identified in this report but not quantified, the total benefits would exceed total costs by an even greater amount.

For the second residential scenario, the benefits from performing the lead-hazard identification are the knowledge that an abatement is not warranted. Therefore, the owner avoids the costs of performing the abatement.

In the case of child occupied facilities, the benefits that the owner derives from the lead-hazard identification and abatement (if warranted) are the avoidance of liability resulting from possible exposure of children to lead-based paint. Again, the increased information provides the owner with the basis for making a better informed decision.

Based on either the comparison of total benefits to incremental costs over the 50-year period, or the net total benefits per unit accruing to owners, it is reasonable to conclude that incremental benefits are likely to exceed incremental costs. This conclusion is bolstered when one considers the benefit categories lacking the information necessary to support estimates with a high degree of confidence. For reasons discussed below, the data limitations are likely to result in the underestimate of benefits and thus, total benefits far exceed the incremental costs. In addition, if it were possible to target abatements so that they were concentrated in target housing units where infants and young children live, then the target housing benefits could be increased at no increase in costs.

8.3.1 Net Effects of Uncertainty in Estimating Costs and Benefits

While the uncertainty in the cost estimates could be in either direction, total benefits are likely to be underestimated. The development of the incremental unit costs for the work practice standards of this rule relied on three steps: the determination of "common" practices, a comparison of these practices to the requirements of the rule, and an estimation of the cost of the additional or incremental activities. The number of people to be trained, and the cost of this training, were estimated based on the estimated number of lead-based paint actions. While there is a general uncertainty about all the estimates, this approach may have resulted in an overestimate of the costs. Many factors in addition to §402(a) of TSCA are leading to improved training and work practice standards for lead-based paint activities. Since incremental costs are estimated by comparing current practices and training to those specified in the rule, these estimates may be higher than would be the case if the requirements were compared to practices likely to be common in the future. Disentangling the effect of this rule from the rest of Title X, and other information and regulatory actions is not possible at this time. In addition, the number of people to be trained may be overestimated, since the estimated supply of trained personnel is based on the assumption that these people would be also engaged in other activities and that on average, lead-based activities would not provide full-time employment. If lead-based activities do constitute full-time employment, then fewer people would need to be trained. This uncertainty, and others, are examined by the sensitivity analysis presented in Chapter 7.

The development of the benefit estimates was also limited by numerous factors. It was not possible to include several potentially major sources of health benefits at this time. To a certain degree, however, some of the major benefits omitted from the primary analysis were included in the sensitivity analysis. The omitted benefit categories include:

- Benefits due to reduced neonatal mortality;
- Benefits to adult residents;

- Benefits to workers who might receive additional benefits under this rule;
- All benefits to building occupants (e.g., teachers);
- All benefits to residents near abatement sites;
- All ecological benefits.

In addition to omitting benefits to occupants of child-occupied facilities, benefits to residents near abatement projects, and ecological benefits, the estimates presented may underestimate benefits because of the assumption made concerning which target housing units will be abated. The analysis assumes that all the housing stock with lead-based paint in deteriorated condition or in good condition on friction surfaces and/or soil-lead levels greater than 5,000 ppm are eligible candidates for abatement, and that housing units receiving abatements are twice as likely to have young children and newborns as the housing stock in general. This second assumption captures the increased concern about lead hazards and children, and the increased benefits that would accrue to households with young children. The increased concern will likely result in increased abatement rates among housing units with children. However, there are no data currently available on which to base an estimate of this increased likelihood of abatement, and the estimate used may be low. A low estimate will result in an underestimate of the average target housing unit benefits. In addition, if the likelihood of abatement increases with the level of lead present in the home, which is very likely, the average per unit benefits of target housing abatement will increase substantially.

The estimate of the total benefits of target housing abatements would increase if all the omitted health and ecological effects were included. Even when restricted to the limited coverage of the effects of lead-based paint exposure that are included in this analysis, it is possible, and even likely, that the measured benefits associated with §§402(a) and 404 will exceed the costs of the regulations. The total measured benefits of abatements are 14.45 times the incremental costs. Thus, if the TSCA §402(a) rules increase the measured benefits of target housing abatements (using current industrial practices) by as little as 7.5 percent[1], the benefits would exceed the costs of the regulation. A benefits analysis that included the significant omitted benefit categories would indicate that an even smaller percentage increase in the benefits of current abatement practices would be sufficient to cover the costs of the regulation. Better targeting of housing units creating the most health and ecological risks would increase the benefits substantially, further reducing the percentage of the total benefits necessary to cover costs.

[1] If 7 percent of the benefits of a total abatement performed following the §§402(a) and 404 regulations were the incremental benefits directly associated with the regulation, then 93 percent (= 1.0-.07) of the measured benefits are due to abatements performed using the current industrial practices. Therefore, the benefits associated with better training and standards are a 7.5 percent (= .07/.93) improvement over the current practices.

9. IMPACTS OF THE REGULATION

In addition to the benefit-cost analysis, several other types of impacts are important to consider in evaluating a regulation. This chapter presents analyses that measure the impact of §402(a) and §404 of Title IV of the Toxic Substances Control Act (TSCA) on small entities (Section 9.1), international trade (Section 9.3), and technological innovations (Section 9.4). The paperwork burden on states, training providers, lead-based paint inspection and abatement firms, and individual lead abatement workers are analyzed in Section 9.2. The question of whether the regulations have a disproportionate effect on low-income and/or minority persons (an environmental justice analysis) is addressed in Section 9.5.

9.1 Impacts on Small Businesses

The 1980 Regulatory Flexibility Act (P.L. 96-354) requires regulators to analyze the impacts of regulations on small entities, in particular small businesses. Based on definitions developed by the Small Business Administration, the size of a business in the sectors affected by this rule is determined by its annual sales. Individual workers do not come under the definition of small business.

Section 402(a) does not require or mandate the abatement of lead-based paint, nor require that any particular enterprise participate in the abatement of lead-based paint. However, §402(a) does require that if an abatement is voluntarily conducted, certain training requirements and work practices must be followed. The costs of required training, licensing, and work practice standards may create competitive differences that could result in unfair burdening of small firms. This analysis estimates both the absolute and the relative burden on small and large businesses.

The §402(a) compliance costs consist of two components that may impact small businesses: 1) accreditation and training costs for workers and supervisors, as well as certification costs for firms, and 2) incremental costs of work practice standards for abatement procedures. These two components coincide with the two decision points faced by firms interested in performing lead-based paint abatement work (including soil abatement). In order to participate in this industry, a firm must be certified and its employees must be trained and certified. Firms incur these expenses in anticipation of work, based on its assessment of the future demand for such services, its competition, and the price it will be able to charge. If the market demand does not meet these expectations, the firm may not recoup these costs, thus decreasing its profits.

The costs resulting from work practice standards are of a different nature. Firms that perform lead-based paint activities often perform similar work in settings that do not involve lead and are not affected by this rule. Occurring at the second decision point, work practice standards costs will be incurred by a firm only if it chooses to undertake a given lead-based paint job. In each situation, the firm can assess the impact of the work practice standards on its sales and profit levels. If the impact is adverse (i.e., results in profit levels below those available for other work), the firm has the option to decline the work. Most firms that perform lead-based paint activities are also active in the non-lead paint markets. In this voluntary setting, the work practice standards will not have an adverse impact on the profits of businesses because these firms can focus, instead, on the non-lead paint business. Therefore, no estimates of work practice standards burden are presented in this analysis. Likewise, owners of property will incur the work practice standards costs only if they determine that an abatement is in their benefit.

9.1.1 Definition of the Industry

Based on the SIC definitions and 1992 Census data, most of the firms affected by this regulation are part of one of two SIC groups:

- SIC 1799 Construction -- Special Trade Contractors, Not Elsewhere Categorized, or
- SIC 8734 Engineering, Accounting, Research, Management, and Related Services -- Testing Laboratories

While there is no separate code for lead-based paint abatement firms, the U.S. Census of Construction Industries does provide data on a group of related activities that includes lead-based paint abatement. The Census of Construction estimates that in 1992, slightly over $2.1 billion of business was done in Asbestos Removal, Lead Paint Removal and Radon Remediation activities combined. Based on the analyses presented in chapters 4 and 5, the lead-based paint removal industry is expected to grow substantially over the next several years. While underrepresenting the total size of the industry, this Census data provide the best available information on the size structure of the industry and so is used for this analysis of impacts on small businesses.

The data do not allow the three activities to be separated. Exhibit 9.1 presents value of sales information for the 3 major components of the construction industry (SIC 15, SIC 16, and SIC 17). In addition, it presents value of activity data for the most relevant subgroup (SIC 1799) as shown. The vast majority of this work was reported by firms in SIC 17, and by far its largest subgroup (in terms of asbestos, lead and radon work) is SIC 1799 -- Special Trade Contractors, NEC. These firms reported conducting over 97 percent of this work, and it comprised slightly less than 15 percent of their work. SIC 1799 covers a wide range of activities by contractors, including: paint and wallpaper stripping, wallpaper removal, sandblasting and steam cleaning of building exteriors, counter top installations, and lead burning.

Similar activity data are not available for lead-based paint inspections, risk assessments and/or project planning. Based on the SIC definitions and the types of activities included in each, however, SIC 8734 appears to be the appropriate one. It includes such activities as: soil testing, pollution control consultants, radon testing and correction, and asbestos consulting and testing.

Exhibit 9.1: Value of Asbestos Removal, Lead Paint Removal and Radon Remediation Activities (1992, Thousands of Dollars)			
	Value of Asbestos and Lead Paint Removal and Radon Remediation Activities	**Value of All Business Activities**	**Asbestos, Lead Paint and Radon Activities as Percent of All Business**
SIC 15 -- General Building Contractors	$863	$220,231,216	0.0004 %
SIC 16 -- Heavy Construction, except Building	$4,306	$98,528,182	0.0044 %
SIC 17 -- Special trade contractors	$2,155,210	$220,325,260	0.9782 %
SIC 1799 -- Special Trade Contractors, NEC	$2,104,122	$14,162,323	14.857 %

In summary, the analysis assumes that lead-based paint inspectors and risk assessors are employed by firms in SIC 8734, while workers, supervisors and project planners are employed by firms in SIC 1799. To the extent that firms in SIC 1799 also employ inspectors and risk assessors, these firms are likely to be among the larger ones and employ all five disciplines. In such cases, the analysis presented is likely to overestimate the number of firms affected and underestimate the costs imposed on larger firms.

9.1.2 Definition of Small

The Small Business Administration (SBA) has developed size definitions to distinguish between large and small entities. For the two SIC groups of interest, these definitions are based on annual sales. For government entities (e.g., cities, towns, countries, states), the definition is based on the number of people living there. The current definitions are:

- $7 million for SIC 1799 (Special Trade Contractors)[1] and

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[1] As published in the Wednesday, January 31, 1996 *Federal Register*, p 3289.

- $5 million for SIC 8734 (Testing Laboratories)[2]
- 50,000 persons for governments.

Since the §402(a)/404 regulations apply to states, none of the government entities are small and the analysis need only address small firms.

As shown in Exhibit 9.2 , the vast majority of establishments in each of the two SIC groups are small: for SIC 1799 about 99 percent and for SIC 8734 about 96 percent are small.[3] The preponderance of firms in SIC 1799 is even smaller than these figures portray. Over one-third of establishments (37 percent) have annual sales of under $100,000, with average annual sales of under $43,000 and average employment of only 1.6 persons. The distribution across size categories is a little more even for SIC 8734, where about 13 percent of the establishments have annual sales below $100,000 (with average annual sales of slightly over $57,000) and average employment of 1.9 persons.

9.1.3 Impact of Regulations on Small Businesses

Two factors are of particular interest when assessing the impact of these regulations on small businesses. One is the number of small businesses affected, and the other is the size of the impact. The impact analysis makes the following assumptions:

- Some, but not all, firms in each of the two relevant SIC groups are involved in lead-based paint activities and thus are affected by these requirements.

- These firms are distributed proportionately across all size categories. For example, since 37.2 percent of all firms in SIC 1799 have annual sales of less than $100,000, then 37.2 percent of lead-based paint abatement firms have sales of less than $100,000.

- On average, the affected firms are like the average firm in their size category, in terms of number of employees and average annual sales.

- Each affected firm trains and certifies all of its employees.

Since most of the firms in each of the two SIC groups are small, the analysis estimates impacts for several size categories within the group of "small" firms, as well as the impacts on the average small and large firm.

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[2] Ibid

[3] The size data reported by the U.S. Census is for establishments, not firms. As such, it may overstate the incidence of small firms, since a firm could own more than one establishment. While each of the establishments might be small, the total annual sales for all establishments owned by the firm might be large. In these particular industries, however, firms are likely to own more than one establishment. Thus any over-estimate of the number of small firms, and commensurate underestimate of average size, will be small.

Exhibit 9.2: Characteristics of Establishments				
	Number of Establishments	**Percent of Total Establishments**	**Average Sales ($)**	**Average Number Employees**
SIC 1799: Small Businesses				
Less than $100k	9,392	37.17%	42,773	1.6
$100 to $249k	5,664	22.41%	161,763	3.5
$250 to $499k	3,859	15.27%	354,328	6.2
$500 to $999k	3,220	12.74%	703,325	10.5
$1 to $2.49 mil	2,151	8.51%	1,525,144	20.6
$2.5 to $4.9 mil	641	2.54%	3,435,056	41.4
$5 to $7 mil	95	0.37%	5,424,933	64.0
Total or Weighted Average-Small	25,022	99.02%	442,920	6.8
SIC 1799: Large Businesses				
$7 to $9.9 mil	144	0.57%	7,704,316	90.9
$10+ mil	104	0.41%	20,235,067	213.2
Total or Weighted Average-Large	248	0.98%	12,404,476	135.7
SIC 8734: Small Businesses				
Less than $100k	532	12.81%	57,195	1.9
$100 to $249k	903	21.75%	171,025	3.6
$250 to $499k	782	18.83%	358,313	6.5
$500 to $999k	745	17.94%	711,117	11.5
$1 to $2.49 mil	753	18.14%	1,587,911	24.3
$2.5 to $4.9 mil	286	6.89%	3,395,601	48.2
Total or Weighted Average-Small	4,001	96.36%	790,224	12.5
SIC 8734: Large Businesses				
$5 to $9.9 mil	113	2.72%	6,811,283	87.5
$10+ mil	38	0.92%	19,885,132	247.3
Total or Weighted Average-Large	151	3.64%	10,101,391	127.7

Number of Firms Affected

As shown in Exhibit 9.3, in 1990 there were over 204,000 persons employed in SIC 1799. Firms in this SIC group employ lead-based paint workers, supervisors and project designers. As shown in Chapter 4, an estimated 11,800 workers, supervisors and project designers will be trained in the first year. These represent 5.8 percent of the employment in this SIC group. Based on these numbers, approximately 1,463 firms (5.79 percent of 25,270) in SIC 1799 will be affected by this rule, of which approximately 1,448 are small.

While there are fewer firms in SIC 8734 than in SIC 1799, potentially a much larger proportion of firms in SIC 8734 are affected by this rule. These firms employ lead-based paint inspectors and risk assessors. As shown in Chapter 4, an estimated 13,700 will be trained in the first year. This represents 19.75 percent of the employment in this SIC group. Based on these numbers, approximately 820 firms (19.75 percent of 4,152) in SIC 8734 are affected by the rule, of which about 790 are considered small.

Size of Impacts

Impacts are estimated by comparing the training and certification costs to be incurred by a firm to the annual sales of that firm. Training and individual certification costs are a function of the number of people to be trained. For simplicity, the analysis assumes that if a firm is going to train its staff, it will train all of them and the firm will bear both the direct and indirect costs of the training.[4] While it is reasonable to assume that most of the small firms will train all of their employees if they train any, it may not be a reasonable assumption for the largest of the small firms and the large firms. The larger firms might train teams for lead-based paint abatement work while using its untrained personnel for non-lead-based paint jobs. To the extent that this is true, average costs will be lower than estimated for large firms and more large firms will be affected than estimated.

As shown in Exhibit 9.3, the average impact on small firms (as measured by the ratio of compliance cost to annual sales) is 0.9 percent for firms in SIC 1799. Among small firms, the impact ranges from a high of 2.8 percent for firms with annual sales of $100,000 or less, down to 0.6 percent for firms with annual sales of between $5 and $7 million. For large firms, the average impact is 0.6 percent. While the impact on small firms is greater than that on large firms, in both cases the impact is small.

The second page of Table 3 presents equivalent estimates for SIC 8743. The average impact on small firms (as measured by the ratio of compliance cost to annual sales) is 1.3 percent for firms in SIC 8734. Among small firms, the impact ranges from a high of 3.2 percent for firms with annual sales of $100,000 or less, down to 1.1 percent for firms with annual sales of between $2.5 and $5 million. For large firms, the average impact is 1.0

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[4] Costs include: tuition, transportation and per diem, as well as lost wages (as a measure of the productivity lost during training). In addition, there is a certification cost for each individual and for the firm.

Exhibit 9.3a: Impact of Training and Certification Costs on Lead Abatement Firms							
SIC 1799: Small Businesses							
	Number of Establishments	Estimated Number of Lead-Based Paint Establishments*	Average Sales ($)	Total Number Employees	Average Number Employees	Cost per Firm ($)**	Firm Cost/Sales
Less than $100k	9,392	544	42,773	14,840	1.6	1,190	2.78%
$100 to $249k	5,664	328	161,763	19,747	3.5	2,204	1.36%
$250 to $499k	3,859	223	354,328	23,845	6.2	3,637	1.03%
$500 to $999k	3,220	186	703,325	33,694	10.5	5,916	0.84%
$1 to $2.49 mil	2,151	125	1,525,144	44,332	20.6	11,313	0.74%
$2.5 to 4.9 mil	641	37	3,435,056	26,522	41.4	22,358	0.65%
$5 to $7 mil	95	5	5,424,933	7,672	64.0	34,402	0.63%
Total or Weighted Average-Small	25,022	1,448	442,920	170,652	6.8	3,978	0.90%
SIC 1799: Large Businesses							
$7 to $9.9 mil	144	8	7,704,316	11,509	90.9	48,710	0.63%
$10+ mil	104	6	20,235,067	22,172	213.2	113,750	0.56%
Total or Weighted Average-Large	248	14	12,404,476	33,681	135.7	72,509	0.58%

* Proportionate share of all establishments based on ratio of workers, supervisors, and project designer to be trained to number of persons employed.

** Average cost per firm equals average training cost per employee ($532) plus certification cost of firm ($350)
Average training cost per employee = $6,306,748/11,827 = $532.

Exhibit 9.3b: Impact of Training and Certification Costs on Lead Abatement Firms							
SIC 8734: Small Businesses							
	Number of Establishments	Estimated Number of Lead-Based Paint Establishments*	Average Sales ($)	Total Number Employees	Average Number Employees	Cost per Firm ($)**	Firm Cost/Sales
Less than $100k	532	105	57,195	1,007	1.9	1,842	3.22%
$100 to $249k	903	178	171,025	3,262	3.6	3,197	1.87%
$250 to $499k	782	154	358,313	5,097	6.5	5,486	1.53%
$500 to $999k	745	147	711,117	8,597	11.5	9,444	1.33%
$1 to $2.49 mil	753	149	1,587,911	18,299	24.3	19,500	1.23%
$2.5 to 4.9 mil	286	56	3,395,601	13,781	48.2	38,322	1.13%
Total or Weighted Average-Small	4,001	790	790,224	50,043	12.5	10,206	1.29%
SIC 8734: Large Businesses							
$5 to $9.9 mil	113	22	6,811,283	9,886	87.5	69,293	1.02%
$10+ mil	38	8	19,885,132	9,396	247.3	195,202	0.98%
Total or Weighted Average-Large	151	30	10,101,391	19,282	127.7	100,978	1.00%

* Proportionate share of all establishments based on ratio of workers, supervisors, and project designer to be trained to number of persons employed.

** Average cost per firm equals average training cost per employee ($788) plus certification cost of firm ($350)
Average training cost per employee = $10,788,202/13,690 = $788.

percent. While the impact on small firms is greater than that on large firms, the differences are not large and overall the impacts are small.

In addition, firms are likely to pass these costs on to their customers in the form of higher prices because the regulations apply to all firms involved in lead-based paint activities. Therefore, the ratios presented in Exhibit 9.3 tend to overestimate the impacts. Since training and licensing costs are a small percent of operating costs, and these percentages are only slightly higher for small businesses than for large ones, the impact of this regulation on small businesses will be small, as is the differential between impacts on large and small businesses.

9.1.4 Reasons for Heavier Impact on Small Establishments

There are two reasons why the rule places a somewhat heavier burden on the smallest firms. Compliance costs consist of two parts: a cost per employee (training and individual certification costs) and a cost per firm (cost to certify the firm). The analysis assumes that the cost to certify a firm is the same regardless of the size of the firm, and thus is a larger percentage of sales for small firms as compared to large ones. For example, the firm certification cost (estimated to be $350) comprises 0.8 percent of average annual sales for the smallest firms in SIC 1799 and only 0.002 percent of annual average sales for the largest firms in SIC 1799. If certification costs varied with the size of the firm, then the impacts would be more even across firm sizes

A larger part of the difference in impacts is due to the relationship between overall size of the firm and the sales per employee exhibited by firms in these industries. While per person training and certification costs do not vary with the size of the firm, the average annual sales per employee increases as the size of the establishment increases. Therefore, the ratio of training and individual certification costs to average annual sales falls as the size of the firm increases.

9.1.5 Impacts on Property Owners and Training Providers

As explained in Section 9.1.3, it is likely that firms involved in lead-based paint activities will increase their prices, shifting the costs onto their customers. While this shifting of costs will alleviate the burden on abatement firms, the incremental costs of the regulations may affect building owners. Consistent with the arguments presented above, under this rule abatement is a voluntary action. As such, property owners are unlikely to undertake an abatement unless they are able to pass the cost on to tenants or otherwise recoup the costs in terms of higher property values. Where abatements are mandated under a state law or local ordinance, however, the costs of this rule may have an adverse impact on landlords. While abandonment could possibly be the result, existing information indicates that this is unlikely (see discussion in Chapter 4, especially Appendix 4.A). Therefore, analyses of potential impacts on property owners or tenants were not performed.

The comparison of impacts on small and large training providers was not performed for two reasons. Except for the RLTCs, most training providers are small, so there would be no differential effect based on size of the firm. In addition, it is likely that the training providers will pass the additional costs on to their trainees, and this impact is analyzed above under the assumption that firms undertaking lead-based paint activities will bear these costs. Since the changes will be required by Federal regulations, they will apply to all training providers. Second, there will be heightened concern about lead-based paint hazards and thus a greater willingness to pay for trained personnel who will presumably provide higher quality services. In fact, these regulations are likely to create a market for training services and thus may be beneficial to small businesses.

9.2 Paperwork Reduction Analysis

Sections 402(a) and §404 of TSCA include a number of reporting and recordkeeping requirements, which are designed to help EPA verify compliance with the rule. Under the Paperwork Reduction Act (PRA), EPA is required to estimate the burden associated with these requirements. This analysis identifies the reporting and recordkeeping requirements specified in this rule and estimates the burden and cost that these requirements will impose.

Sections 402(a) and §404 will add to the reporting and recordkeeping burden for five entities: states, training providers, lead inspection and abatement firms and individuals, building owners, and EPA. Burden numbers were based on those developed for the Asbestos Model Accreditation Plan (MAP)(USEPA, 1993b) and the analysis presented in Chapter 5.

Reporting burdens presented are classified into two groups: initial and annual. The burden associated with start-up efforts are referred to as the initial burden. For the purpose of this analysis, all of these efforts are assumed to be completed during the first year that the rule is effective. The burden associated with reporting that will be required on an annual basis are referred to as the annual burden and are presented based on the projected activity level for the first year that the rule is in effect. Initial and annual estimates are combined to project the burden and costs that will be imposed in the first year the rule is in effect, while the annual costs alone serve as an estimate of the burden level expected during the second and all subsequent years of the rule.

9.2.1 Reporting Requirements

States, Indian Tribes and/or Alaskan Native Villages In order to obtain authorization from EPA to administer and enforce a state or tribal program under §§402(a) and 404, states, Indian Tribes and/or Alaskan Native Villages are required to:[5]

[5] For simplicity of presentation, the term "state" is used to refer to states, Indian Tribes, and Alaskan Native Villages.

- submit a notice of intent to seek authorization,

- prepare an application for state approval identifying the state agency(s) responsible for implementation, administration, and enforcement of the program and a description of the authority and responsibilities vested in such agency(s),

- undergo legislative and regulatory efforts (this requirement applies only to states that do not currently have a lead licensing and certification program in place), and

- submit report (following authorization) to the Administrator detailing measures of performance, output, and results of the program. Reports must be provided annually for the first three years, then biannually thereafter.[6]

Data collected from seven states to assess the burden associated with preparing a similar application package for state approval of the Asbestos MAP, and five states to assess the likely burden of this regulation, were used to estimate the burden of the application process required by this rule. Similar data were not available for the notice of intent and the annual report. Therefore, these numbers were estimated using the same hourly wage rates and ratio of professional to clerical labor as used for estimating the burden of approval. Costs associated with legislative and regulatory efforts were estimated based upon the experience of Minnesota in their lead licensing and certification program.

The total burden on states due to their reporting requirements is estimated at 45,635 hours in the first year the rule is effective and 2,750 hours each following year (see Exhibit 9.4). The costs to states due to their reporting requirements is projected to be about $894,800 in the first year and $53,900 each year thereafter. As discussed in Chapter 5, these estimates assume that all 55 states and other entities, including the District of Columbia, and four Indian Tribes and/or Alaskan Native Villages, will seek EPA authorization and begin program implementation during the first year of the rule.[7] Therefore, estimates presented in Exhibit 9.4 provide the upper bound of the first-year state burden. If all states do not seek authorization in the first year, the total burden is not expected to change, but rather shift from the first year to later years.

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[6]If implementation problems arise, state reporting may revert back to an annual basis at the discretion of EPA. Because it is not possible to predict the number of states (if any) that will encounter implementation problems, the analysis assumes that all states will report annually for the first three years, then bi-annually thereafter.

[7]Appendix 5C identifies the Indian Tribes and Native Villages, and describes the basis for assuming four tribes and/or groups of villages will participate in this aspect of the program.

Exhibit 9.4: Burden Associated with State Reporting Requirement

	Professional Hours per State		Clerical Hours per State		Total Labor	Total Hour Burden	
	Hours	$/Hours	Hours	$/Hours	Costs	(55 states & other entities)	Total Cost
Initial Burden:							
Program Authorization (required of 55 states & other entities):							
Notice of intent	8	$21.25	2	$13.02	$196	550	$10,782
Application for state approval	58	$21.25	14	$13.02	$1,415	3,960	$77,813
Legislative and Regulatory Burden (required of 35 states)	940	$21.25	235	$13.02	$23,035	41,125	$806,215
Total Initial Burden						45,635	$894,810
Annual Burden: (Annually for Three Years, Biennially Thereafter)							
Annual report	40	$21.25	10	$13.02	$980	2,750	$53, 914
Total Annual Burden	40		10		$980	2,750	$53,914
Total Burden - first year effective (including first annual report)						48,385	$948,724
Total Burden-Year Two and Three, Biennially Thereafter	40		10		$980	2,750	$53,914

Note: Wage rates for state officials were obtained from state data collected for the Regulatory Impact Analysis of the Interim Rule to Revise the Asbestos Model Accreditation Plan (USEPA, 1993b), updated to reflect 1994 wage rates using the GDP inflator.
*Includes 50 states, District of Columbia, and four Indian Tribes and/or Alaskan Native Villages.

Training Providers To gain accreditation, training providers are required to submit the following documents to EPA:

- an accreditation statement that clearly indicates how the training program meets the minimum requirement for accreditation, or a statement that indicates that the training program will use the EPA curriculum,

- a copy of the course test, a description of the activities and procedures for conducting the assessment of hands-on skills, and a description of the facilities and equipment for lecture and hands-on training, and

- a quality control plan, which outlines procedures for periodic revision of training materials and exams, annual reviews of instructors, and adequacy of training facilities.

The burden of completing the accreditation statement varies depending on whether the training provider adopts the EPA-developed curriculum or chooses to use its own training curriculum. The burden associated with providing documentation that demonstrates that a non-EPA curriculum meets the minimum requirements is significantly greater than adopting the EPA curriculum. Despite this greater burden, many training providers have already developed their own curriculum and may prefer to continue to teach it.

Given the similarity between requirements, data collected to assess the burden of preparing an accreditation statement for training approval under the Asbestos MAP were used to estimate the burden of the training provider approval process required by this rule. Based on the Asbestos MAP, the burden associated with the preparation of the accreditation statement is estimated to be 4 hours when EPA curriculum is adopted and 40 hours if the training provider develops their own curriculum. Lacking any basis to estimate the proportion of training providers that will adopt the EPA curriculum, the analysis assumes that 90 percent will adopt the EPA curriculum, resulting in an average burden of 7.6 hours ((0.90 × 4 hours) + (0.10 × 40 hours)) for completion of the accreditation statement. Similar data were not available for the quality control plan; therefore, these numbers were estimated using the same hourly wage rates and ratio of professional to clerical labor as were used for estimating the burden of the accreditation statement. The analysis estimates that 8 hours of training provider time and 2 hours of clerical time will be required to prepare a quality control plan. The total number of training providers seeking accreditation was estimated based on the estimated number of people to be trained and information provided by the state of California (see Chapter 5).

Sections 402(a) and 404 specify that the states must reaccredit training providers every four years. Little data are available regarding the burden of reaccreditation; therefore, the analysis makes the simplifying assumption that reaccreditation will involve one-half the time (3.8 hours) required for initial certification. An audit may also be performed by states to verify the contents of re-certification applications. The analysis assumes that 10 percent of

Exhibit 9.5: Burden Associated with Training Provider Reporting Requirements

	Professional		Clerical		Labor Costs per Training Provider	Number of Training Providers	Total Hour Burden	
	Hours	$/Hours	Hours	$/Hours				Total Cost
Initial Burden:								
Rule Familiarization	8	$26.70	0	$10.68	$214	200	1,600	$42,720
Accreditation statement	7.6	$26.70	2	$10.68	$224	200	1,920	$44,856
Quality control plan	8	$26.70	2	$10.68	$235	200	2,000	$46,992
Total Initial Burden	23.6		4		$673		5,520	$134,568
Quadrennial Burden:								
Re-Accreditation	3.8	$26.70	1	$10.68	$112	200	960	$22,428
Audit	0.2	$26.70	0.4	$10.68	$10	200	120	$1,922
Total Quadrennial Burden	4		1.4		$122		1,080	$24,350
Total Initial Burden	**24**		**4**		**$673**		**5,520**	**$134,568**
Total Quadrennial Burden	**4**		**1**		**$122**		**1,080**	**$24,350**

Note: Wage rates were obtained from training provider data collected for the Regulatory Impact Analysis of the Interim Rule to Revise the Asbestos Model Accreditation Plan (USEPA, 1993b), updated to reflect 1994 wage rates using the GDP inflator.

all training providers applying for re-accreditation will be audited in a given year. The audit burden is estimated to be 2 hours of professional and 4 hours of clerical time, assuming that much of the work will involve assembling files for the auditor. These estimates draw on those developed for the Asbestos MAP.

The burden associated with training provider reporting requirements is estimated at about 5,500 hours in the initial year and 1,080 hours every 4 years thereafter (see Exhibit 9.5). The cost associated with the reporting requirements is estimated at $134,600 in the initial year. Assuming that all training providers will seek accreditation during the initial year of the rule, yields the highest cost estimate. This assumption does not account for any attrition or replacement of training providers that may take place. However, the number of individuals requiring training drops in subsequent years, since only replacement personnel need to receive initial training. If it is assumed that not all training providers will seek accreditation in the first year, then the need to accredit new training providers would be offset by a decline in demand for training. Further, the burden imposed on a single training provider, 28 hours and $670 is low relative to the total burden associated with the rule. The quadrennial burden is estimated to be 1,080 hours and $24,350 for re-accreditation and state auditing related requirements.

Lead Inspection and Abatement Firms In order to participate in lead-based paint activities that are regulated under this rule, lead abatement firms are required to seek certification from the approving authority. The certification letter must state that the firm will follow the standards set forth in the rule and will employ only certified employees. The number of firms seeking certification (2,825) was developed in Chapter 4.

After receiving certification, firms are required to complete a number of reports when performing lead-based paint activities, including:

- an inspection report describing the areas inspected;
- a risk assessment/lead hazard screen report, which includes the sampling results, associated hazards, and recommended actions;
- a pre-abatement notification for buildings with two or more units informing authorities of intention to abate;
- an occupant protection plan; and
- a post-abatement report detailing the activities undertaken to eliminate the hazard, including clearance testing results.

The time required to complete a certification letter and the reports described above was estimated. This analysis assumes that there are no incremental costs associated with inspection reports because these reports are currently used in the industry.

Exhibit 9.6: Burden Associated with Reporting Requirements for Firms Performing Lead-Based Paint Activities								
	Prof. Hours	$/Hours	Clerical Hours	$/Hours	Total Labor Costs	Number of Events	Total Burden Hours	Total Burden Cost
Initial Burden:								
Rule Familiarization	6	$26.70	0	$10.68	$160.23	2,825	16,952	$452,689
Certification letter	1	$26.70	0.5	$10.68	$32.05	2,825	4,238	$90,538
Total Initial Burden	7		0.5		$192.27		21,190	$543,227
Annual Burden:								
Target Housing								
Risk Assessment and Lead Hazard Screen Reports*	1.86	$21.68			$40.32	65,529	121,884	$2,642,451
Pre-abatement notification	0.5	$23.02			$11.51	18,056	9,028	$207,827
Occupant Protection Plan	1	$20.53**			$20.53	55,506	55,506	$1,139,543
Post-abatement reports	2	$20.25			$40.50	55,506	111,012	$2,248,002
Target Housing - Soil Abatements								
Pre-abatement soil notification	0.5	$23.02			$11.51	281	140	$3,234
Occupant Protection Plan	1	$20.53**			$20.53	1,325	1,325	$27,199
Post-soil abatement reports	2	$20.25			$40.50	1,325	2,650	$53,656
Child-Occupied Facilities								
Risk Assessment and Lead Hazard Screen Reports	1.09	$21.68			$23.66	500	546	$11,829
Pre-abatement notification	0.5	$23.02			$11.51	500	250	$5,755
Occupant Protection Plan	1	$20.53			$20.53	500	500	$10,265
Post-abatement reports	2	$20.25			$40.50	500	1,000	$20,250
Child-Occupied Facilities - Soil Abatements								
Pre-abatement soil notification	0.5	$23.02			$11.51	3	2	$39
Occupant Protection Plan	1	$20.53			$20.53	5	5	$105
Post-soil abatement reports	2	$20.25			$40.50	5	10	$208
Total Burden - first year effective							**325,049**	**$6,913,588**
Total Burden - each subsequent year							**303,859**	**$6,370,362**

* Risk assessments for Target Housing include paint and soil.
** Wage rate is a weighted average of Project Planner and Supervisor. Project Planner will complete pre-abatement plan in buildings with 10 or more units; Supervisors will complete in all other units.
Note: Wage rates were obtained from Bureau of Labor Statistics data.

The burden associated with completing the various reports is estimated at 325,000 hours in the initial year and 303,900 in each following year (see Exhibit 9.6). The costs associated with the reporting requirements are estimated at $6.9 million in the initial year and $6.4 million in each following year. First and second year costs are similar because preparing and filing the certification letter (the only extra initial activity) is not very costly, and abatement activity remains fairly stable over the 50 years.

Since the reports will be completed by the inspector, risk assessor, designer, or supervisor, they will not require any clerical support. The burden estimate assumes that all firms will seek certification during the first year of the rule, the resulting estimate of costs is conservative. This assumption does not account for any attrition that may take place. If firms seek certification in later years, the total burden is not expected to change; rather, it will shift from the first year to later years.

Individuals In order to become certified, an individual must apply to the certifying authority. Reporting requirements for certification are the same for inspectors, risk assessors, and supervisors; and for workers and project designers.

The requirements for certification for inspectors, risk assessors, and supervisors include submitting proof of:

- completion of a training course
- passing the course test
- meeting the educational and/or experience requirements

It is estimated that it will take one hour to gather and send these documents per individual.

The requirements for project designers and workers include proof of:

- completion of a training course

It is estimated that it will take one-half hour to gather and send this document per individual.

The total cost associated with individual certification reporting requirements are estimated to be about $439,700 in the first year the rule is effective (see Exhibit 9.7). The burden associated with individual certification reporting requirements is estimated to be roughly 22,430 hours in the initial year. This burden will decrease in subsequent years because the analysis assumes that over-training will occur in the first effective year of the rule.

Total Reporting Costs Exhibit 9.8 summarizes the burden estimates for all entities subject to reporting requirements under Title IV. During the first effective year of the rule, the burden is projected to be about 401,000 hours and $8.4 million. Assuming all entities seeking accreditation and certification are in place during the first year of the rule, the burden estimate associated with the second year is projected to be 312,235 hours and $6.5 million (including the individual reporting burden).

The majority of the burden falls on firms performing lead-based paint activities and is driven by the reporting requirements associated with on-site lead-based paint activities.

Exhibit 9.7: Individual Reporting						
	Hours	**$/Hours**	**Total Labor Costs**	**Number of Reports**	**Total Burden Hours**	**Total Cost**
Total Burden:						
Target Housing						
Inspectors	1	$20.22	$20.22	7,461	7,461	$150,868
Risk Assessors	1	$21.68	$21.68	5,990	5,990	$129,858
Supervisors	1	$20.25	$20.25	5,559	5,559	$112,567
Worker	0.5	$12.39	$6.20	5,816	2,908	$36,028
Project Designers	0.5	$23.02	$11.51	247	124	$2,844
Child-Occupied Facilities						
Inspectors	1	$20.22	$20.22	217	217	$4,391
Risk Assessors	1	$21.68	$21.68	22	22	$471
Supervisors	1	$20.25	$20.25	98	98	$1,990
Worker	0.5	$12.39	$6.20	102	51	$632
Project Designers	0.5	$23.02	$11.51	4	2	$51
Total Burden - first year effective				**25,516**	**22,432**	**$439,700**
Note: Wage rates were obtained from Bureau of Labor Statistics data, updated to reflect 1994 wage rates using the GDP inflator.						

9.2.2 Recordkeeping Requirements

Recordkeeping requirements specified in §402(a) and 404, and the method used to estimate their cost, are presented below. Total costs are summarized in Exhibit 9.9.

Firms Performing Lead-Based Paint Activities Under §402(a) recordkeeping requirements, inspection and abatement firms (or states in the case of pre-abatement notifications) must maintain the following reports:

- Risk Assessment/Lead Hazard Screen (RA/LHS) Report
- Pre-Abatement Notification
- Occupant Protection Plan
- Post-Abatement Report

It is assumed that the length of these reports on average will be 3, 2, 2, and 3 pages respectively. These records must be kept for a period of no less than three years. Based on discussions with industry representatives, it is assumed that there are no incremental costs associated with inspection report recordkeeping because this is current industry practice.

Exhibit 9.8: Total Burden Associated with Reporting Requirements		
	Total Hours	**Total Cost**
Initial Burden:		
State	48,385	$948,724
Training Providers	5,520	$134,568
Lead Inspection and Abatement Firms	325,049	$6,913,588
Individuals	22,432	$439,700
Total Initial Burden	**401,386**	**$8,436,580**
Annual Burden:		
State (annually for three years, biannually thereafter)	2,750	$53,914
Lead Inspection and Abatement Firms	303,859	$6,370,362
Total Annual Burden	**306,609***	**$6,424,276***
Triennial Burden		
Training Providers	1,080	$24,350
Total Quadrennial Burden	**1,080**	**$24,350**

* The annual burden imposed by individual reporting (Exhibit 9.6) varies according to the number of individuals trained each year; therefore, the burden and cost associated with individual reporting is not presented here.

The costs associated with recordkeeping fall under two categories: labor and materials. The materials cost estimates used in this analysis rely on the burden estimates developed for the analysis of §406 (USEPA, 1993c); labor cost estimates are based on the Asbestos MAP.

Labor costs consist of the time associated with the actual filing of the records. The analysis of §406 estimates that the time associated with filing each report, regardless of size, is 0.5 minutes or .0083 hours. The wage rate ($10.68) associated with the filing time was based on data from the Asbestos MAP. Total labor costs are calculated as follows:

(# of Hours per Report) * (# of Reports) * (Wage Rate) = (Total Labor Cost)

Exhibit 9.9: Burden Associated with Lead Inspection and Abatement Recordkeeping Requirements

Type of Report	# of Events	Avg. # of Pages	Total # of Pages	Labor Cost (Filing): # of Hours per Report/Plan	Labor Cost (Filing): # of Plans	Labor Cost (Filing): Total Hours	Labor Cost (Filing): Cost/Hour	Labor Cost (Filing): Total Labor Cost	Materials Cost: Copying Cost: Cost per Copy	Materials Cost: Copying Cost: Total Copying Cost	Materials Cost: Filing Cost: Cost per Page	Materials Cost: Filing Cost: Total Filing Costs	Materials Cost: Total Materials Cost	Total: Total Annual Cost
Target Housing														
RA/LHS Report	65,529	3	212,249	0.0083	65,529	544	$10.68	$5,809	$0.03	$6,367	0.004	$849	$7,216	$13,025
Pre-Abatement Notification	18,056	2	36,112	0.0083	18,056	150	$10.68	$1,601	$0.03	$1,083	0.004	$144	$1,228	$2,828
Occupant Protection Plan	55,506	2	111,012	0.0083	55,506	461	$10.68	$4,920	$0.03	$3,330	0.004	$444	$3,774	$8,695
Post-Abatement Report	55,506	3	166,519	0.0083	55,506	461	$10.68	$4,920	$0.03	$4,996	0.004	$666	$5,662	$10,582
Target Housing Soil														
Pre-Abatement Notification	864	2	1,728	0.0083	864	7	$10.68	$77	$0.03	$52	0.004	$7	$59	$135
Occupant Protection Plan	1,325	2	2,650	0.0083	1,325	11	$10.68	$117	$0.03	$79	0.004	$11	$90	$208
Post-Abatement Report	1,325	3	3,975	0.0083	1,325	11	$10.68	$117	$0.03	$119	0.004	$16	$135	$253
Child-Occupied Facilities														
RA/LHS Report	500	3	1,620	0.0083	500	4	$10.68	$44	$0.03	$49	0.004	$6	$55	$99
Pre-Abatement Notification	500	2	1,000	0.0083	500	4	$10.68	$44	$0.03	$30	0.004	$4	$34	$78
Occupant Protection Plan	500	2	1,000	0.0083	500	4	$10.68	$44	$0.03	$30	0.004	$4	$34	$78
Post-Abatement Report	500	3	1,500	0.0083	500	4	$10.68	$44	$0.03	$45	0.004	$6	$51	$95
Child-Occupied Soil														
Pre-Abatement Notification	3	2	7	0.0083	3	0	$10.68	$0	$0.03	$0	0.004	$0	$0	$1
Occupant Protection Plan	3	2	5	0.0083	3	0	$10.68	$0	$0.03	$0	0.004	$0	$0	$0
Post-Abatement Report	3	3	8	0.0083	3	0	$10.68	$0	$0.03	$0	0.004	$0	$0	$0
Total Cost - first year effective						**1,661**		**$17,739**		**$16,181**		**$2,158**	**$18,339**	**$36,078**

* Records must be maintained for a period of three years. In year four and beyond, the total cost will not include materials cost associated with filing (approximately $2,160). This represents a 9 percent savings from first year costs.

Materials costs include copying and filing space costs. Copying costs are calculated based on $0.03 per copy multiplied by the total number of pages to be copied; only one copy is required. As developed in the §406 analysis, filing costs are calculated based on a $0.004 cost per page multiplied by the total number of pages. These costs are double because two parties will file the reports.

The total recordkeeping cost for lead inspection and abatement firms and building owners for the initial year is estimated at $36,000. Since abatement activities remain fairly constant, similar costs will be incurred for the following two years. Section §402(a) only requires that records be maintained for a period of three years; therefore, in year four and beyond, the total cost will not include materials costs associated with filing (approximately $2,160). This represents a 9 percent savings from the initial year's costs.

Training Providers Sections 402(a) and 404 requires that training providers keep records on:

- Qualifications of the training manager, principal instructors, and work practice instructors
- Curriculum/course materials
- Course exam
- Hands-on methodology
- Student files (including hands-on skills assessment and test, and a copy of the course certificate).

These records must be held for a period of 3½ years. It is estimated that, in total, training provider records will be 11 pages plus two pages for each of their students. Copying costs are attributed only to the 11-page application. Therefore, the costs associated with recordkeeping for training providers include labor and materials for filing. These costs are calculated as described in the lead inspection and abatement firm recordkeeping section above.

Costs are based on 200 training providers and 17,700 people trained for all disciplines in the initial year. This results in an estimated $1,800 total cost for training providers. In year four and beyond, there will be no materials costs for filing which will result in an 8 percent savings from the initial year's costs.

9.3 Impacts on International Trade

The industries directly affected by this final rule are service, as opposed to manufacturing, industries. The reduction in lead-based paint hazards is achieved through the identification and abatement of lead-based paint on structures in the United States and will have no international trade impacts. Both the training and the abatement activities covered by this rule are provided domestically, and there is no appreciable international trade in these services.

9.4 Impacts on Technological Innovation

No analysis of innovation was attempted at this time. While this regulation does not require the use of any particular practices, it does require that certain results be achieved. This is likely to encourage innovation. For example, the standards require that the presence of lead be determined by a test that produces discrete measures. At the moment, there are only two approaches that meet this criteria and this requirement eliminates the chemical tests used in many states. While setting criteria for any new approaches, the rule does not eliminate innovation by requiring the use of a particular method, such as XRF.[8]

9.5 Environmental Justice (Equity) Analysis

When promulgating a regulation, the EPA investigates whether there are disproportionate burdens on particular groupings of households or individuals. Of particular concern are burdens on low income and/or minority households. The proposed regulations require training and certification of lead-based paint inspection and abatement personnel, plus increased standards of performance. These requirements may either serve as a barrier to persons and firms wanting to enter the lead-based paint industry, or they will result in an increase in the costs of inspections and abatements. Since a substantial portion of the costs are associated with residential inspections and abatements and these costs will be borne most directly by the residents, the environmental justice analysis focuses on measuring the impact on residential households. First, however, it considers possible impacts on minority personnel and firms.

9.5.1 Minority Firms and Personnel

The training, certification and performance standards might place a disproportionate burden on minorities if minorities tended to be overrepresented among:

- Owners of small firms — Section 9.1 concludes that the ratio of compliance costs to sales is inversely related to size of firm.

- Personnel who are just entering the field — Persons with prior training and experience can become certified under the grandfather clause, which relies on refresher training as opposed to initial training. Refresher training takes less time and is much less costly than initial training.

Since there are no systematic databases that provide information on minority participation as owners or staff of firms performing lead-based paint identification or abatement work, this analysis relies on information collected from interviews with the

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[8]One instrument for measuring the presence of lead in paint is X-ray fluorescence (XRF), which provides discreet measures in terms of milligrams of lead per square centimeter of paint. For example, paint with an XRF of 1 is paint with 1 mg. of lead per square centimeter of paint.

Regional Lead Training Centers (RLTC) consortium members. Interviews were conducted with seven RLTC consortium members. While none had extensive data, they all presented similar impressions. They reported that while most of the firms are small, few of the firms are owned by minorities. It also was the impression of some respondents that the minority firms were not getting their share of the business. In terms of people getting training, a relatively high percentage of worker trainees were from minority groups, but supervisor trainees tended to be white. Likewise, fewer minorities appear to be enrolled in inspector or risk assessor courses.[9] Several respondents spoke of programs, both federally and locally funded, to encourage minority training. Again, some of the respondents were concerned that while trained, these minority workers were not getting the jobs. Based on this anecdotal information, it is difficult to draw any conclusions as to whether there is a disproportionate effect on minority businesses and personnel.

9.5.2 Minority Households

The most important equity issues involve residential abatements and the households affected. Lead-based paint can occur in virtually all segments of the United States housing stock constructed before the lead content of household paint was banned in 1978. A successful national program to eliminate lead-based paint hazards must reach every community with housing built before 1978, and every population sub-group in the United States. However, even though lead-based paint is widespread throughout the United States, and affects every socio-economic group, the distribution of lead-based paint is not uniform with respect to region of the country, age of housing stock, race, household income and cost of housing. Lead-based paint is more common in older low-cost housing units in the North-East and Mid-West than in other units. Because these housing units tend to be occupied by households at or below the poverty level, poorer households are likely to be disproportionately more exposed to lead-based paint than other sub-populations. Because African-Americans make up a disproportionate share of households at or below the poverty level (especially in the North-East and Mid-West where the incidence of lead-based paint is the most common), African-Americans are likely to be disproportionately more exposed than other racial groups.

The segments of our population that are disproportionately exposed to lead-based paint have the greatest potential risk reduction, and thus benefit from this rule. However, because most of the abatements covered by §402(a) are voluntary, relatively wealthier households are more likely to proceed with the risk-reducing abatements. Thus, while the risks from lead-based paint are now disproportionately borne by lower income people, the risk reductions that occur due to lead-based paint abatement (and hence the benefits of performing better abatements due to §§402(a) and 404) may tend to be concentrated among

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[9]For example, one RLTC consortium member responded that 10 to 20 percent of contractor trainees were minority, while only 5 to 10 percent of inspector and risk assessor trainees were minority. Another respondent said that overall, 46 percent of trainees were minority. Several simply said they had more minorities in their work training courses than in their other courses.

the wealthier members of the population currently living in houses with lead-based paint. This tendency will be mitigated, however, in states that mandate lead-based paint activities.

This section of the report describes the distribution of lead-based paint in the housing stock, and considers the environmental justice implications of that distribution. A thorough analysis of the environmental justice implications of this rule would require two types of information: data that directly linked the presence of lead-based paint hazards in each housing unit to the racial and income characteristics of the residents of this unit, and data on the likely probability that residents will choose to have an inspection, risk assessment, and/or lead-based paint abatement performed. Since this detailed information is not available at this time, an alternative investigation was undertaken. For each relevant characteristic (i.e., age of unit, regional location, monthly housing costs, household income, and race), housing units with lead-based paint hazards are compared to the general housing stock. These comparisons indicate whether housing units with lead-based paint hazards are more or less likely than the general housing stock to have low-income or minority residents. The limited information available on both the distribution of lead-based paint (based on the U.S. Department of Housing and Urban Development (HUD) data) and the lack of solid evidence about the likely pattern of voluntary abatements make it impossible to reach a complete understanding of the environmental justice implications of §§402(a) and 404. Looking at the separate elements, however, indicates whether or not lead-based paint hazards are likely to fall disproportionately on low-income and/or minority households.

While there is risk to human health from any concentration of lead-based paint, lead levels of one mg/cm^2 or greater are used throughout this Regulatory Impact Analysis as the paint concentration level of concern. Therefore, this section compares the equity impacts at different levels of lead concentrations. The risks, and thus the potential benefits, increased as lead concentrations increased. For purposes of comparison, the two measures of lead-based paint concentration examined in this section are:

- XRF greater than or equal to one mg/cm^2, and more than five square feet of paint in deteriorated condition.

- XRF greater than or equal to six mg/cm^2, and more than five square feet of paint in deteriorated condition.

One of the most commonly used methods for determining lead content in paint is XRF.[10] Risk increases substantially if the lead-based paint is in deteriorated condition, since the paint can be more easily ingested. Therefore, the analysis focuses on paint with an elevated lead level that is in deteriorated condition. As will be seen in this section, while the incidence of houses with XRF readings over one mg/cm^2 is disproportionately concentrated

[10]This section is based on data collected and reported in terms of XRF reading. Therefore, this section also reports the results in terms of XRF.

in certain segments of the population, the incidence of XRFs greater than one, and especially greater than six, with paint in deteriorated condition is much more disproportionate.

The distribution of lead-based paint conditions is estimated using data from the national survey of lead-based paint in housing sponsored by HUD. The HUD survey was a national stratified random sample of 284 privately owned, occupied housing units built before 1980. HUD developed national sampling weights for each observation, to create a weighted national sample representing the 77.1 million privately-owned and occupied housing units built before 1980 that were in use in 1990. All the analysis in this section is based on the HUD estimates of the national pre-1980 housing stock.

The incidence of XRF levels in the national housing stock of pre-1980 houses is shown in Exhibit 9.10.

Exhibit 9.10: National Incidence of Lead-Based Paint (XRF Levels)

	XRF ≥ 1	XRF ≥ 1 and paint in deteriorated condition	XRF ≥ 6 and paint in deteriorated condition
National Incidence in Pre-1980 Housing Stock	34.6%	8.5%	2.6%

9.5.2.1 Age of Housing Stock

In general, high levels of lead-based paint are more common in older housing stock. Even though lead was not banned in household paint until 1978, the lead content of paint declined after World War II. This is reflected in the distribution of the age of the housing stock that has high XRF levels, shown in Exhibit 9.11. For example, 42 percent of the housing stock with a maximum XRF reading of 6 mg/cm^2 or more, and with more than five square feet of paint in deteriorated condition, was built before 1930, even though only 21 percent of the existing stock of pre-1980 housing units is that old. The shading in the exhibits in this section indicates a disproportionate incidence of a hazard (i.e., the actual incidence of a hazard in a sub-population is at least five percent more than the sub-population's share of the pre-1980 housing stock). It is important to realize that even though the older units are more likely to have a lead-based paint hazard, hazards do exist in some housing units of all ages.

Exhibit 9.11: Distribution of Age of Housing Units				
Year Built	**Pre 1980 Housing Stock**	**Housing Stock With XRF ≥ 1**	**XRF ≥ 1 and paint in deteriorated condition**	**XRF ≥ 6 and paint in deteriorated condition**
Pre 1930	21%	**27%**	**29%**	**42%**
1930 - '49	13%	16%	14%	15%
1950 - '65	43%	45%	**52%**	42%
1966 - '78	22%	12%	6%	-
Total	*100%*	*100%*	*100%*	*100%*
Totals may not sum to 100% due to rounding.				

9.5.2.2 Regional Distribution

Because the North-East and Mid-West regions of the country tend to have relatively more older housing units than the South and West, those regions would be expected to have more lead-based paint than regions with newer housing stock. Although lead-based paint does disproportionately occur only in the North-East, disproportionately high levels of lead-based paint in deteriorated condition occur in both the North-East and Midwest. For example, of the national housing stock with maximum XRF readings of 1 mg/cm^2 or more, 36 percent occur in the North-East region. If we consider housing stock with high XRF readings and paint in deteriorated condition, then the Mid-West and North-East account for 36% and 38% respectively. In contrast, the HUD survey found that the South region, while having 34 percent of the total housing stock, has only 15 percent of the houses with a combination of high XRF readings and paint in deteriorated condition. Exhibit 9.12 shows the regional distribution of the XRF levels.

Exhibit 9.12: Regional Distribution of Housing Units				
Region	**Pre-1980 Housing Stock**	**Housing Stock With XRF ≥ 1**	**Housing Stock With XRF ≥ 1 and deteriorated paint condition**	**Housing Stock With XRF ≥ 6 and deteriorated paint condition**
Mid West	25%	22%	**36%**	**38%**
North-East	22%	**36%**	**38%**	**47%**
South	34%	23%	14%	15%
West	19%	20%	12%	-
Total	*100%*	*100%*	*100%*	*100%*

Totals may not sum to 100% due to rounding

9.5.2.3 Cost of Housing

The environmental justice effects of the uneven regional and housing age distribution of XRF levels are compounded by an uneven distribution of various demographic and socio-economic sub-populations. Although some of the nation's older housing stock is premium real estate, and commands a high market price, in general older housing units are less expensive than newer units. The higher incidence of high XRF levels in the older housing stock is related to the fact that people living in lower cost housing are disproportionately exposed to the lead-based paint hazards. The incidence of XRF levels by monthly housing cost (measured as either monthly rent or monthly mortgage payment to amortize a ten percent mortgage in 30 years, not including taxes or insurance) is shown in Exhibit 9.13. The least expensive housing (less than $250 per month) has a share of elevated XRF levels somewhat higher than its proportion of the population, and a share of stock with both the highest XRF levels and paint in deteriorated condition nearly three times higher than its share of overall housing stock. Notice that the problem is not confined to low-cost housing. Even the most expensive housing units have some incidence of elevated XRF levels and deteriorated paint condition.

9.5.2.4 Income

As would be expected, the relationship of XRF levels and income reflects the fact that poorer people tend to live in the lower-cost houses, and thus bear a disproportionate share of the exposure to lead-based paint hazards. Exhibit 9.14 shows the distribution of household income and XRF levels; households with low incomes are much more likely to live in housing with higher XRF levels.

Exhibit 9.13: Distribution of Monthly Housing Costs				
Monthly Housing Cost	**Overall Housing Stock**	**Housing Stock With XRF ≥ 1**	**Housing Stock With XRF ≥ 1 and deteriorated paint condition**	**Housing Stock With XRF ≥ 6 and deteriorated paint condition**
< $250	17%	18%	**25%**	**46%**
$250-$500	29%	30%	21%	16%
$500-$750	18%	15%	22%	**26%**
$750-1500	20%	15%	19%	3%
> $1500	16%	**22%**	14%	9%
Total	*100%*	*100%*	*100%*	*100%*

Totals may not sum to 100% due to rounding

Exhibit 9.14: Distribution of Household Annual Income and XRF Levels				
Household Annual Income	**Overall Housing Stock Distribution**	**Housing Stock With XRF ≥ 1**	**Housing Stock With XRF ≥ 1 and deteriorated paint condition**	**Housing Stock With XRF ≥ 6 and deteriorated paint condition**
< $10k	19%	23%	**26%**	**40%**
$10 - 20k	16%	13%	6%	9%
$20 - 30k	19%	20%	19%	**25%**
> $30k	40%	37%	41%	23%
NA	6%	8%	8%	3%
Total	*100%*	*100%*	*100%*	*100%*

Totals may not sum to 100% due to rounding

9.5.2.5 Race

The HUD survey found that lead-based paint is more likely to affect African-Americans than other racial sub-populations (race is defined as the stated race of the youngest person in the household). This is a result of both the larger African-American share of the population in the North-East and Mid-West, and of the higher poverty rate for African-Americans. The disproportionate risk faced by groups classed as "other" may be due to recent immigrant populations living in relatively inexpensive housing, or to higher than average poverty among some of these groups. Exhibit 9.15 shows the distribution of XRF levels by race.

Exhibit 9.15: Population Distribution by Race

Race	Overall Housing Stock	Housing Stock With XRF ≥ 1	Housing Stock With XRF ≥ 1 and bad paint condition	Housing Stock With XRF ≥ 6 and bad paint condition
African-American	9%	11%	**17%**	**42%**
Hispanic	7%	7%	8%	5%
White	78%	71%	59%	48%
Other	7%	10%	**17%**	4%
Total	*100%*	*100%*	*100%*	*100%*

Totals may not sum to 100% due to rounding.

9.5.2.6 Other Socio-Economic Variables

The incidence of lead-based paint on other socio-economic variables does not show as dramatic a disproportionate incidence as the region, income and race variables. Exhibit 9.16 shows the incidence for the following variables:

- Ownership: rental units are somewhat more likely to have high XRF readings, and much more likely to have extremely high XRF readings with deteriorated paint condition.

- Female head of household (defined as no male over the age of 18 living in the house): less likely to live in a unit with both high XRF readings and deteriorated paint condition.

- Presence of children 6 years old or less: there is a disproportionate incidence of lead-based paint hazards among units with young children, due to paint in deteriorated condition rather than to than higher lead levels than in other units.

- Elderly (defined as at least one person over the age of 65 living in the unit): units including elderly people are less likely to have both high XRF readings and deteriorated paint conditions.

Exhibit 9.16: Distribution of Other Household Demographic Characteristics				
	Overall Housing Stock	**Housing Stock With XRF ≥ 1**	**Housing Stock With XRF ≥ 1 and bad paint condition**	**Housing Stock With XRF ≥ 6 and bad paint condition**
Ownership				
Rent	35%	**41%**	34%	**47%**
Own	65%	59%	66%	53%
Female Head of Household?				
No	88%	90%	**98%**	**100%**
Yes	12%	10%	2%	-
Children ≤ 6 Years Present?				
No	82%	81%	64%	68%
Yes	18%	20%	**36%**	**32%**
Anyone ≥ 65 Years Present?				
No	76%	78%	**92%**	**100%**
Yes	24%	22%	8%	-
Totals may not sum to 100% due to rounding.				

9.5.2.7 Housing Units with Various Levels of Lead Hazards

An XRF level equal to one is the level chosen by the EPA for use as a standard. Information presented in the analysis about XRF values greater than one, and in particular XRF values greater than or equal to six, indicates, for illustrative purposes, how higher-risk exposure is distributed. In this section, we show that the distribution of risk from XRF values greater than six fairly represents risks for large XRF values (roughly, XRF greater than or equal to three). Exhibit 9.17 shows the percentage of those in selected segments of the population exposed to lead-based paint in deteriorated condition with successively higher XRF values. For all selected segments other than African Americans, the proportion levels off at XRF between three and four. However, the table shows that the share of exposure borne by African Americans continues to rise for XRF values up to 7. Thus, disproportionate risk seems to be borne by African Americans, in addition to the risk associated with poverty.

Exhibit 9.17
Percentage of Housing Units Exposed to Varying XRF Levels (With Bad Paint Conditions) Borne by Selected Segments of the Population

Category	All Housing Units	1	2	3	4	5	6	7
Income < $10,000	19%	26%	31%	39%	42%	38%	40%	42%
African American	9%	17%	26%	32%	37%	40%	42%	44%
Rent < $250/mo	17%	25%	32%	37%	43%	43%	46%	48%
built before 1930	21%	29%	36%	43%	42%	45%	42%	40%

9.5.8 Environmental Justice Conclusions

Existing lead-based paint hazards are a risk to all segments of our population living in pre-1980 housing. However, the HUD survey does indicate that some segments of our society are at relatively greater risk than others. In particular, the residents of older, low-cost housing are exposed to a disproportionately greater share of the exposure than other housing units. The housing stock in the North-East (and to some extent the Mid-West) includes a larger share of such units than other regions, creating a regional inequity in the incidence of the problem. Because poorer people usually occupy low-cost housing, the hazards disproportionally fall on lower income sub-populations (especially households living in poverty, with annual incomes below $10,000), creating an income inequity. Finally, the relatively larger share of African-Americans in the lower income groups potentially results in racial inequities.

The major shortcoming of this environmental justice analysis is its inability to directly incorporate the differing levels of demand for abatements that result from different income levels. Although the baseline risks from lead-based paint disproportionately fall on poorer sub-populations, abatement may well be more likely to occur in housing units occupied by wealthier households. Likewise, the value placed on the benefits may vary with income levels due to the different anticipated earnings levels, as well as the usual income effect. Most of the abatements under the Lead-Based Paint Hazard Reduction Act of 1992 will be voluntary, and wealthier households are more likely to have the means to abate an existing problem in their home, or avoid moving into a housing unit with a known lead-based paint hazard. Thus even though a national strategy of eliminating lead-based paint risks targets a problem affecting a greater share of poor households and African-Americans, the impact of income on the ability to undertake voluntary abatements may result in a more inequitable distribution of the risks in the future.

9.6 Unfunded Mandates

In evaluating the impacts of a regulation, EPA determines whether it contains any federal mandates that would result in the expenditure of $100 million or more by any particular party, public or private. EPA has determined that this rule does not result in the expenditure of $100 million or more by any State, local or tribal government, or by anyone in the private sector.

In addition, pursuant to Title II of the Unfunded Mandates Reform Act of 1995 (P.L. 104-4), EPA has determined that this regulatory action does not contain any "federal mandates," as described in the Act, for the States, local, or tribal governments or private sector because the rule implements mandates specifically and explicitly set forth by the Congress in TSCA section 402(a) and section 404 without the exercise of any political discretion by EPA.

Appendix 9.A
Adjusting U.S. Census Data for the Small Business Analysis

Two adjustments to the U.S. Census data were necessary for this analysis: 1) estimate the number of firms in each size and SIC category engaged in lead-based work, and 2) divide one of the size categories for SIC 1799 to conform with the Small Business Association definition of small.

Estimation of Number of Firms Doing Lead Work

While the majority of firms engaged in lead-based paint activities are likely to be in either SIC 1799 or 8734, the majority of firms in these SIC groups are not likely to be engaged in lead-based paint activities. To estimate the number of firms doing lead work, the estimated number of employees who will receive training were used (11,827 employees in SIC 1799, and 13,690 employees in SIC 8734, was compared to the employment in each of the two SIC groups). Applying the percentage of employees in each SIC who would need training (5.79% and 19.75%, respectively) to the total number of establishments yielded an estimate of 1,463 lead-based establishments in SIC 1799, and 820 in SIC 8734.

Estimation of Split for Sales, Number of Firms, and Average Employment

The Small Business Administration defines small businesses for SIC 1799 as those firms with annual sales under \$7 million.[11] Because \$7 million falls in the size increment \$5-\$9.9 million collected by the U.S. Bureau of the Census, the data within this increment were split. Two-fifths of the dollar range fell below the small business benchmark, and three-fifths fell above. The first step was to estimate the average annual sales for the establishments in the two new categories (\$5-\$6.9 million, \$7-\$9.9 million). The second step was to estimate the average number of employees at these average firms. Finally, the number of firms in each of these two categories was estimated.

To calculate the average sales in the \$5-\$6.9 and \$7-\$9.9 million categories, the midpoint for each size category (\$5.95 and \$8.45 million respectively) was calculated. Then, for each of the seven size categories used by the U.S. Census (from sales less than \$100,000 to sales of \$5-\$9.9 million), the ratio of the average sales to the midpoint of its range was calculated. These ratios were closely grouped around the average of the ratios (.9118). The average sales for each of the two size categories was arrived at by multiplying the midpoints of the two categories with this average ratio. Average sales were found to be \$5.42 and \$7.7 million.

To find the average number of employees for the two categories, the average sales per employee found in the \$5-\$9.9 million category (\$84,693) was divided into each of the

[11] The Small Business Association size cutoff for SIC 8734 matched the size categories used by the U.S. Census.

average sales for each of the two groups. The average number of employees per firm were found to be 64 and 91 employees respectively. The number of establishments was based on the number of firms and the average sales for $5-$9.9 million and the average sales for the two subcategories. The number of firms in each subcategory was estimated.

In summary, it was estimated that there were 95 establishments in the $5-$6.9 million category and 144 establishments in the $7-$9.9 million category. Total employment was found to be 6,064 and 13,117 respectfully, and total sales were $513,889 and $1,111,523. A check was performed by adding the total employees in the two subcategories, as well as the total sales; in both cases they equaled the amounts in the $5-$9.9 million category.

10. CHANGES IN FINAL RULE AND CONCLUSIONS

In the September 2, 1994 issue of the *Federal Register*, EPA published the Proposed Rule: Lead; Requirements for Lead-Based Paint Activities. The proposed regulation was developed by EPA's Section 402/404 Lead-Based Paint Activities Workgroup, in close consultation with representatives of the regulated community and other interested parties. Containing personnel from both EPA Headquarters and Regions, the Workgroup members were very knowledgeable about lead-based paint hazards and approaches to reducing them. When the Proposed Rule was published, EPA actively sought comments and suggestions for improvement. In response to this publication, the Agency received numerous comments from the regulated community, public interest and environmental groups, and other interested and/or affected parties.

After carefully reviewing these comments and analyzing their suggestions, EPA made several changes to refine the regulation. While no alternative options are formally analyzed in this RIA, alternative definitions and requirements have been considered throughout the process of developing the Proposed Rule, soliciting and considering public input and developing the Final Rule. With these refinements, it is EPA's intent to make the regulation more efficient, to reduce costs while preserving the major potential benefits.

These changes resulted in a rule that is limited to requirements that are central to providing the information and infrastructure mandated under §402(a) of TSCA. The changes made by EPA are of two types. One set of changes involve revisions to definitions and affect all parts of the regulation. The second set involves changes to specific requirements. The first set contains several changes:

- A new category of buildings was created; child-occupied facilities were separated from other public buildings.

- This rule-making no longer covers other public and commercial buildings and steelstructures. They will be addressed in a separate rule-making.

- The §403 guidance, published in July 1994, was used in defining when abatements might be considered appropriate.

These three changes serve to target the regulation on those instances where net benefits are likely to be largest, thus increasing the average benefits per activity. At the same time, this set of changes tends to reduce the cost of the rule by reducing the number of units that are subject to the more restrictive and costly aspects of this regulation.

This final rule concentrates on reducing the exposure of children because, as shown in Chapter 3, young children are particularly susceptible to the adverse affects of lead. Therefore, actions that will reduce childhood exposure will reap substantial benefits. In this

Final Rule, child-occupied facilities are treated like target housing. Other public buildings, along with commercial buildings and steelstructures, will be the subject of a separate rule-making. Thus, activities with the greatest impact on children (because they involve sites where children are likely to spend significant amounts of time) are subject to the same training and work practice requirements.

Since the regulatory impact analysis of the Proposed Rule was performed before the §403 guidance was available, the earlier analysis examined two possible scenarios. One assumed that abatements would be appropriate whenever there was lead-based paint (as measured by an XRF of 1 or more) or when soil contained lead levels of 500 ppm or more. The second scenario assumed that abatements would occur when lead-based paint had an XRF of 6 or greater or soil contained lead levels of 2,000 ppm or more. Based on the §403 guidance, however, the analysis of the Final Rule assumes that lead hazards are likely to exist when lead-based paint is either in deteriorated condition or in good condition on friction surfaces, or when soil contains lead in levels of 5,000 ppm or more. Both of these situations will contribute to dangerous lead levels in dust and thus to lead hazards.

In addition to the changes discussed above, the Agency made a set of smaller changes intended to streamline the requirements to reduce the burden on regulated communities while maintaining the benefits of the Proposed Rule. The specific differences between the Proposed and Final Rules are listed in Exhibit 10.1. Under the Final Rule, training has been shortened for three professional groups (project designer, supervisor, and worker), thereby reducing the costs of training these groups. In terms of work practice standards, the Final Rule includes two changes that have opposing effects on costs. The Final Rule restricts the use of certain abatement techniques that were not restricted under the Proposed Rule. Since most of these techniques are not widely used in target housing and child-occupied facilities, these restrictions increase the average cost of an abatement by only a small amount. On the other hand, under the Final Rule, EPA has reduced the number of soil and dust samples to be analyzed as part of the post-abatement clearance, thus reducing costs. In addition, EPA no longer specifies the amount of soil to be removed in a soil abatement. By leaving it up to the risk assessor to determine the appropriate action, the amount of soil to be removed has probably been reduced. This has also reduced the costs of abatements.

Additional changes made as EPA moved from the Proposed to the Final Rule have no measurable impact on costs. For example, EPA has changed the necessary qualifications for instructors in the training courses, and the course content. Based on discussions with training providers, however, it is the number of hours of training that has the largest effect on tuition costs. Length of training also determines the non-tuition costs of training.

Other changes simply clarified sections of the Rule. For example, the Final Rule makes it clear that abatements can occur at the component level. The analysis had always included partial or component abatements. Likewise, training hours always included time for breaks and lunch.

Exhibit 10.1 Comparison of Regulatory Requirements		
	Proposed Rule	**Final Rule**
Training Requirements		
Project Designer	56 hours (separate course)	40 hours
Supervisor	40 hours	32 hours
Worker	32 hours, (10 hours of which are hands-on training)	16 hours (8 hours of which are hands-on training)
Work Practice Standards		
Paint Abatements	No restricted nor banned practices	Open flame burning is banned or prohibited. Heat gun use, machine sanding or grinding, abrasive blasting, and sandblasting are restricted.
Soil Abatements	Soil replacement for up to 24 inches was specified. Costs assumed removal and replacement of 6 inches	Several soil abatement approaches are allowed. Costs assume soil replacement to the depth of 2 1/2 inches (currently the common standard) as the most likely approach around target housing and child-occupied facilities.
Post-Abatement Clearance	13 dust samples on average	5 dust samples on average for interior abatements

There is one change that the analysis could not accommodate, resulting in a slight overestimate of costs under the Final Rule. The rule now explicitly limits abatement of contaminated soil to bare soil conditions. The data available on the prevalence of soil with different levels of lead does not distinguish between bare soil and soil with grass or other ground cover. (This does not include paved soil.) Not knowing what percentage of soil is bare, the analysis assumes that all soil is bare. Since there are very few cases of soil with lead concentrations of 5,000 ppm, this limitation does not increase the cost estimate by very much.

Exhibit 10.2
Comparison of Costs Under the Proposed and Final Rules*
50-Year Costs, Discounted at 3 Percent

	Proposed Rule	Final Rule	Cost Savings	Cost Savings as Percent of Proposed Rule Costs
Training Costs	$267 million	$228 million	$39 million	15%
Work Practice Standards Costs	$1,201 million	$637 million	$564 million	47%
State Administration Costs**	$125 million	$249 million	($124 million)	(99%)
Total Costs of Rule	$1,593 million	$1,114 million	$479 million	30%

* Cost estimates for both Proposed and Final Rules are based on the revised definitions of lead hazards, and include target housing and child-occupied facilities while excluding other public buildings. In addition, the proposed and Final Rule costs both reflect the use of partial abatements.

** The increased estimate of state administrative costs are a result of updated information, not any change in regulatory requirements.

The changes in the rule have resulted in substantial cost savings. Major changes that reduced costs include reductions in training requirements and changes in work practice standards affecting soil abatements. As shown in Exhibit 10.2, changes in training requirements have reduced training costs by 15 percent, resulting in a reduction in total costs of about 2.4 percent. As shown in the sensitivity analysis (Chapter 7), the changes in work practice standards affecting soil abatements have reduced work practice standards by about 46 percent. In Exhibit 10.2, this reduction is reflected in both the Proposed Rule and Final Rule costs, since the Proposed Rule costs reported in that table already include changes due to definition of lead hazard. The remaining reductions in the costs attributable to work practice standards reflect changes in rule language concerning when lead hazard screens and risk assessments are appropriate. Offsetting these cost decreases are increases in costs resulting from state program costs. Most of this increase is due to more complete and up-to-date data, which indicate higher average costs than originally estimated. In addition, state costs include estimates for Indian tribes and Alaskan Native Villages, which were inadvertently left out of the earlier calculations. Despite this doubling of the state cost estimates, total costs drop by nearly one-third.

These cost reductions have been achieved with only a minimal reduction in the benefits resulting from the rule. As shown in Chapter 8, total measured benefits are about 14 times the incremental costs of this rule. Without the cost savings realized under the Final Rule, total measured benefits would have been about 10 times the incremental costs. The cost savings have, therefore, been substantial. In addition, by reducing the incremental cost of activities under this rule, the Agency hopes to encourage more properly-performed actions and thus a greater reduction in lead-based paint hazards.

In developing the Proposed Rule, EPA's objective in reducing risks due to exposure to lead-based paint hazards resulted in a set of regulations that were conservative in the sense of being restrictive. After careful consideration of the comments received from the public, EPA has decided that the rule could be better focused and certain restrictions could be loosened. The result is a rule that more efficiently accomplishes the same objectives.

Conclusion

The purpose of this Regulatory Impact Analysis (RIA) was to analyze the benefits, costs, and economic impacts of the final rule implementing §§402(a)/404. As described above, the incremental costs of this rule are estimated to be $1,114 million, if discounted at a rate of 3 percent. The potential benefits to society associated with lead-based paint hazard reduction is great. The benefits measured in this analysis include $16.1 billion from the avoidance of negative impacts on children's intelligence. In addition, there are possible benefits from neonatal mortality, workers and adult residents of target housing, which could bring the total benefits to as much as $54 billion over 50 years. While it was not possible to estimate incremental benefits due to this rule, total measured benefits far exceed its incremental costs.

Another way to evaluate the rule is to look at it from the perspective of the individual decision maker. The costs facing the typical owner (composed of the total costs of an inspection, risk assessment and abatement, including the incremental costs resulting from the work practice standards, and the unit's pro-rated share of training costs and state administration costs) are $7,276, of which only $248 are incremental costs due to this rule. Compared to the per residential abatement benefits to children of $9,181, total benefits exceed total costs. In addition, the total net benefits are larger than this comparison indicates because data limitations preclude the valuing of several benefit categories. If the property owner has a lead-hazard identification performed (e.g., inspection/risk assessment) and decides that an abatement is not warranted, then the benefit to the owner equals the cost avoided because the abatement is not performed. In the case of child occupied facilities, the information from the lead-hazard identification provides the basis for avoiding potential liability from possible exposure of children to lead hazards.

Based on all this information, EPA believes that §§402/404 provides a vehicle that will aid in the realization of the benefits resulting from the reduction in risk from lead-paint hazards, and that in light of the potential magnitude of these benefits, this rule is reasonable

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